



# **NAVAL POSTGRADUATE SCHOOL**

**MONTEREY, CALIFORNIA**

**Extensible 3D (X3D) Earth  
Technical Requirements Workshop  
Summary Report**

Don Brutzman, Amela Sadagic and Terry Norbraten, Eds.

01 August 2007

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## **ABSTRACT**

The initial X3D Earth Technical Requirement Workshop called together leading researchers, developers and industry experts to determine a broad set of technical requirements that will be necessary to construct an X3D Earth. This workshop was held 14-15 November 2006 at the Naval Postgraduate School (NPS) in Monterey, California, USA.

The main goal in the creation of an Extensible 3D (X3D) Earth will be achieved by Web3D Consortium members who are preparing to build a standards-based suite of software tools usable by governments, industry, scientists, academia and the general public. X3D mappings of world terrain, cartography and imagery will be made available for use in any scene, making it easy to geospatially reference and share X3D models. Open standards, the Web architecture, utilization of the Extensible Markup Language (XML) and open protocols will be leveraged throughout. Both commercial and open-source software codebases will be able to utilize these best practices and contribute to these shared assets.

The goal of this technical requirements workshop was for participants to identify and prioritize the technical requirements, available capabilities, open challenges and strategic partnerships needed for a Web3D working group to execute this ambitious project. Emphasis was placed on extensibly adapting existing resources and in cooperation towards achieving shared goals, especially with other open geospatial organizations and standards. These workshop results document participant contributions, next-step activities and goal milestones.

The workshop concluded that X3D Earth is feasible and that the effort can be started now. Many resources are already available, yet work will be needed to make them compatibly available. No showstoppers were discovered; a nice surprise after so many diverse inputs. Finally, lots of collaboration and coordinated work are needed to proceed successfully in order to build a web-services infrastructure and develop a server-side specification to enable X3D Earth.

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## ACRONYMS AND ABBREVIATIONS

ACM	Association for Computing Machinery
AJAX	Asynchronous JavaScript and XML
API	Application Programmer Interface
BIM	Building Information Model
BML	Battle Management Language
CAD	Computer Aided Design
CFP	Call for Participation
CJMTK	Commercial Joint Mapping Toolkit
C <sup>2</sup>	Command and Control
DIS	Distributed Interactive Simulation Protocol
DRM	Digital Rights Management
EMS	Emergency Medical Services
EPSG	European Petroleum Survey Group
ESRI	Environmental Systems Research Institute
IPR	Intellectual Property Rights
GeoRSS	Geographical Rich Site Summary
GIS	Geospatial Information Systems
GML	Geography Markup Language
GMU	George Mason University
GPS	Global Positioning System
HLA	High Level Architecture
HTTP	Hypertext Transport Protocol

IEEE	Institute of Electrical and Electronics Engineers
IMS	IP Multimedia Subsystem
IP	Internet Protocol
JC3IEDM	Joint Consultation Command & Control Information Exchange Data Model
KML	Keyhole Markup Language
LIDAR	<u>L</u> ight <u>D</u> etection <u>A</u> nd <u>R</u> anging
MBARI	Monterey Bay Aquarium Research Institute
MOU	Memorandum of Understanding
MOVES	Modeling, Virtual Environments and Simulation
NEW	Network Education Ware
NPS	Naval Postgraduate School
NUWC	Naval Undersea Warfare Center, Newport, RI
OGC	Open Geospatial Consortium
OMG	Object Management Group
P2P	Peer-to-Peer
QoS	Quality of Service
RSS	Rich Site Summary
SAI	Scene Access Interface
SAVAGE	Scenario Authoring and Visualization for Advance Graphical Environments
SCIF	Sensitive Compartmented Information Facilities
SEDRIS	Synthetic Environment Data Representation and Interchange Specification

SIGGRAPH	Special Interest Group for Computer Graphics
SIPRNET	Secret Internet Protocol Router Network
SISO	Simulation Interoperability Standards Organization
SRM	Spatial Reference Model
S&ST	Sound and Sea Technologies
UHRB	Ultra High Resolution Building Model
URL	Uniform Resource Locator
VBIED	Vehicle-Based Improvised Explosive Device
VR	Virtual Reality
VT	Virginia Polytechnic Institute (Virginia Tech)
VRML97	Virtual Reality Modeling Language, ISO standard of 1997
WCS	Web-coverage Service
Web3D	Web3D Consortium
WSA	Web Service Architecture
WWW	World Wide Web
W3C	World Wide Web Consortium
Xj3D	Extensible Java-based 3D Rendering Application Codebase
XML	Extensible Markup Language
XMPP	Extensible Messaging and Presence Protocol
X3D	Extensible 3D Graphics
X3DE	X3D Earth
3D	Three Dimensional

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# **I. EXTENSIBLE 3D (X3D) EARTH INTRODUCTION**

## **A. WORKSHOP STRUCTURE**

### **1. Overview**

The initial X3D Earth Technical Requirement Workshop called together leading researchers, developers and industry experts to determine a broad set of technical requirements that will be necessary to construct an X3D Earth. This workshop was held 14-15 November 2006 at the Naval Postgraduate School (NPS) in Monterey, California, USA.

### **2. Summary of X3D Earth Goals**

Web3D Consortium members are preparing to build a standards-based X3D Earth usable by governments, industry, scientists, academia and the general public. X3D mappings of world terrain, cartography and imagery will be made available for use in any scene, making it easy to geospatially reference and share X3D models. Open standards, the Web architecture, XML languages and open protocols will be used throughout. Both commercial and open-source software codebases will be able to utilize these best practices and contribute to these shared assets.

### **3. Workshop Goal**

Participants will identify and prioritize the technical requirements, available capabilities, open challenges and strategic partnerships needed for a Web3D working group to execute this ambitious project. Emphasis will be placed on extensibly adapting existing resources and cooperating to achieve shared goals, especially with other open geospatial organizations and standards. Workshop results will document participant contributions, next-step activities and goal milestones.

#### **4. Participant Preparation**

Prospective attendees were asked to submit a short whitepaper or descriptive slideset in advance of the workshop. In this way, each participant might be well versed in other presenter's ideas, and also confident that their own ideas were well expressed. This approach enabled a deeper (and more rapid) exploration of the many technical issues relevant to commencing an X3D Earth (X3DE) working group and development effort.

#### **5. Submission Requirements**

Prospective participants were first required to submit a brief abstract discussing why they should attend. Prior to the workshop, all attendees were requested to provide a 2-4 page summary and short slideset regarding their area of interest, so that all participants can contribute to achieving the "big picture" goals. Whitepaper topics include following issues:

- Strategic goals statement for community or domain of interest
- Requirements for X3D Earth technical architecture and shared implementations
- Assets already available: datasets and datastreams, software, hardware, labor, etc.
- Access and intellectual property rights (IPR) restrictions
- Unresolved challenges and open questions that still need to be addressed

Participation in this workshop was open to all interested stakeholders whose input abstracts were accepted. Each workshop participant was able to present a summary of their goal requirements, available assets and continuing efforts. Ongoing participation in subsequent X3D Earth Working Group activities is only expected to be available to institutional and professional members of the Web3D Consortium.



## **6. Dissemination of Information**

All technically sound written submissions were accepted and published online as part of the X3D Earth public website. Each contributor's ability to physically attend the workshop was not a prerequisite for inclusion.

Contributions may be published immediately if desired. The organizers recommend this approach in order to gain the benefit of immediate dialog on the public mailing list.

Contributors may modify or defer publication of their contributions prior to the workshop. Afterwards, all contributions are online and publicly available.

## **B. KEYNOTE PRESENTATION**

### **1. Project Overview**

In partnership with other contributing Web3D members, the NPS team proposes to use the Web architecture, XML languages and open protocols to build a standards-based X3DE usable by governments, industry, scientists, academia and the general public.

### **2. X3D Earth: What is it?**

- Build a backdrop X3D (Web3D Consortium, 2004) model of planet Earth
- Use publicly available terrain datasets
- Use publicly available imagery
- Use X3DGeospatial Component (Brutzman & Daly, 2007) throughout
- Provide linkable location for any place
- Provide hooks for physical models
- Use open standards, extensions and process

### **3. Why X3D Earth is needed**

- Proprietary commercial approaches are viable, but not necessarily over long term
- Many past commercial failures, shutdown
- Even very large companies sometimes subject to economic pressures beyond their control
- Government, science, research and academic needs are different than commercial needs
- Public and government assets need to be openly available over long term, indefinitely
- Huge investment in data preparation
- Future rework/rewrite may not be possible
- Archiving, availability is essential prerequisite for many agencies
- New spatial applications become possible including Semantic Web (Daconta, Obrst, & Smith, 2003) and search applications
- Not intended as a commercial competitor to other schemes
- They already have technologies of choice, economic imperatives and business models
- Viva la difference
- Some commercial approaches may actually benefit by having and open approach widely available, providing new services and products

### **4. The key challenge is scalability**

Because the only information systems capable of scalably growing to match global scope are the Internet and the World Wide Web (WWW), X3D Earth will deliberately follow the architectural principles of WWW (Jacobs, Walsh, & et. al., 2004).

## **5. Data**

- 3D, Geospatial Information Systems (GIS) communities have a wealth of data and imagery
- Both freely available and sustainably funded
- Significant metadata usually included
- Many different formats, not always searchable
- Let's get consistent and professional about how to represent, compose and harmonize such data in X3D
- Create "path of least resistance" to success
- Some converters already available (e.g. KML2X3D) (Media Machines, 2006)

## **6. Science**

- Researchers model the world in detail already, but rarely interconnect on to another
- Most interesting part of "virtual reality" (VR) is reality – which means physics
- Need hooks to connect physics engines, virtual sensors, propagation algorithms and live sources

## **7. Stepping up is inevitable**

- Long-running experience in 3D graphics has shown that each accomplishment leads to new (and sometimes unforeseen) challenges
- "Graphics Internetworking: Bottlenecks and Breakthroughs," Chapter 4, Digital Illusion (Dodsworth, 1998)
- X3D's past and present are a prelude to our next steps

**8. Partnerships are big trump cards**

- The hardest parts of the technical infrastructure are already proven possible
- Web3D X3D specifications (Web3D Consortium, )
- World Wide Web Consortium (W3C) Recommendations (*World Wide Web Consortium.*)
- OpenGIS Consortium (OGC) specifications (OGC, 2006)
- Simulation Interoperability Standards Organization (SISO) standards (*SISO, 2006*)
- Object Management Group (OMG) approaches (*Object Management Group, 2006*)
- Two Web-Enabled Modeling and Simulation (WebSim) symposia have demonstrated that large partnerships can work

**9. Server-side 3D graphics**

- Our classical bias in the Association for Computing Machinery (ACM) Special Interest Group for Computer Graphics and Interactive Techniques (SIGGRAPH) (*ACM SIGGRAPH news — siggraph.org.*) community is to think in terms of client-side 3D graphics
- With terrain databases, imagery, cartography and worlds of related objects, the subject of attention becomes server-side 3D graphics
- New issues of interest include preprocessing, prerendering, decimation and compression, digital signature, encryption, streaming, etc. Fresh work mainstreaming X3D awaits.

**10. Proven success story**

- Web3D Consortium members have the capabilities, resources and staying power to undertake this major new Web initiative.
- Proof point: NPS already proposing and executing multiple ambitious projects with many Web3D members
- All this work is unencumbered, repeatable

**11. Conclusions and Recommendation**

- Lots of successes have brought us here today
- X3D Earth is necessary and feasible
- Needed for government assets, science, research and public access
- Lots of demonstrated work can be applied
- Web3D consortium members should undertake an X3D Earth project as a strategic initiative
- Good work can contribute in a coherent way
- Good outcomes can result for everyone

**12. Next steps, workshop**

- Announce SIGGRAPH Boston, MA, 1-3 August 2006 (complete)
- Establish X3D Earth working group in Web3D (complete) (*Web3D Consortium - X3D Earth.*)
- Industry, standards groups, agencies, universities and other implementation teams invited to participate (ongoing)
- Fall workshop at NPS inviting all key player (complete)
  - Price of admission: point paper listing requirements, capabilities and needs
  - Total sum = working group agenda

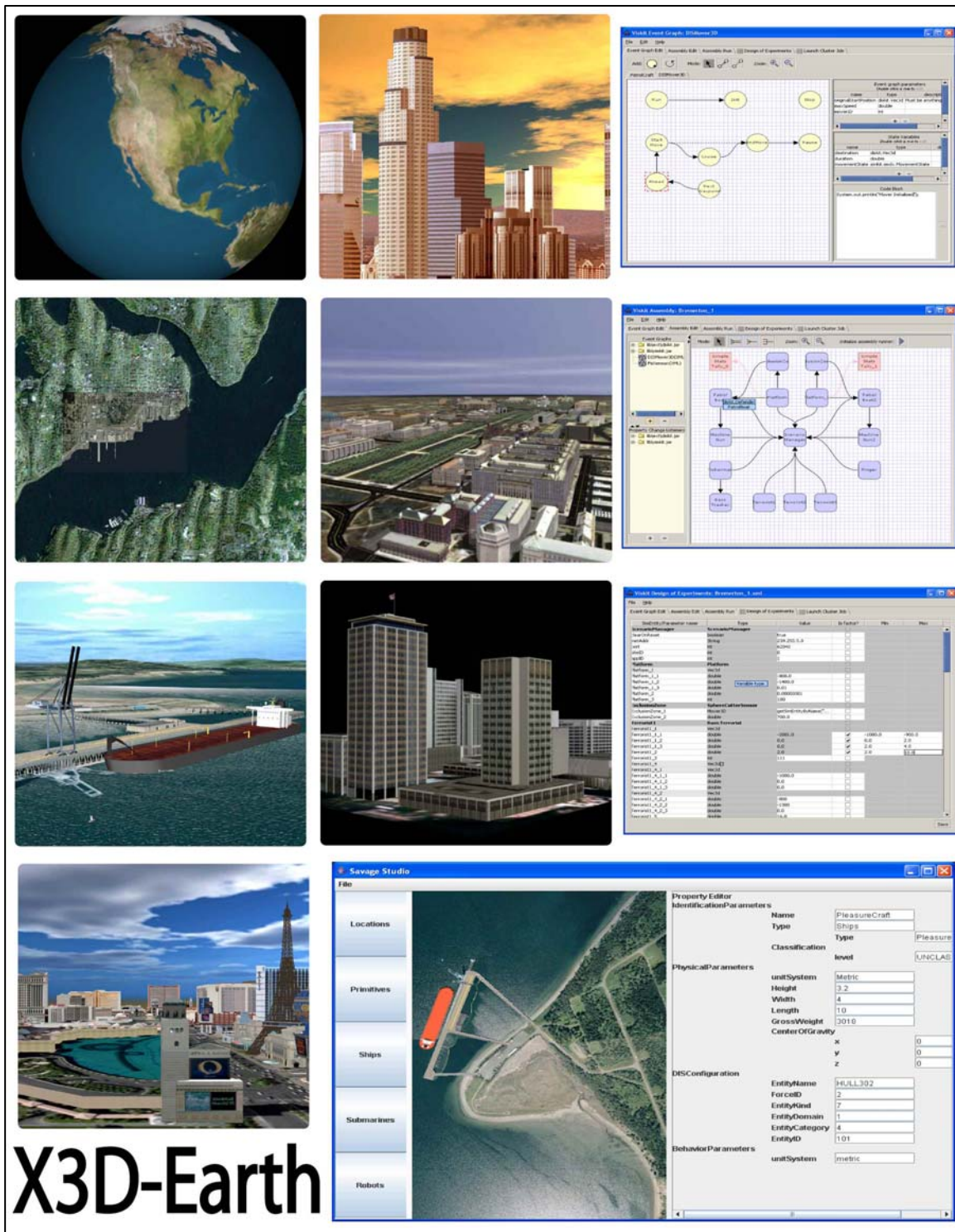


Figure 1. Montage of Visual Concepts Courtesy of Aniviza, Inc., NPS MOVES, Planet 9 Studios, and Yumetech, Inc.

## **C. TECHNICAL REPORT ORGANIZATION**

### **1. Chapter I, X3D Earth Introduction**

This chapter presents workshop structure and the keynote presentation of guiding principles for establishment of X3D Earth.

### **2. Chapter II, Contributor Presentations**

This chapter includes all participant presentations and white papers from the workshop. These are the primary products of the workshop.

### **3. Chapter III, Web3D Consortium Technical Requirements**

This chapter presents a long and detailed list of candidate technical requirements for X3DE. This list was generated through an extensive email dialog held on the Web3D Consortium mailing lists and during weekly X3D Working Group teleconferences. Discussion moderation and requirements compilation was performed by Alan Hudson, Web3D Consortium President.

### **4. Chapter IV, Participant Discussion**

This chapter presents excerpted dialog point, question and answers from the workshop dialog. Many fruitful discussions occurred. Dialog synopses are provided from minutes taken by Amela Sadagic and Terry Norbraten of NPS, and Rita Turkowski of the Web3D Consortium, with further inputs by attendees.

### **5. Chapter V, Conclusions and Recommendations**

This chapter synthesizes the workshop conclusions and recommendation for future work.

**6. Appendix A, Workshop Call for Participation (CFP)**

The X3D Earth Technical Requirements Workshop Call for Participation (CFP) was distributed widely September – November 2006 with public announcement at the [www.web3d.org](http://www.web3d.org) website.

**7. Appendix B, List of Attendees**

Two dozen attendees participated in the workshop. Several other individuals also contributed substantively. Contact information and affiliation are listed here.

**8. Appendix C, Workshop Agenda**

The agenda provided a fast-paced schedule for attendees to present their work and discuss the numerous issues of common and controversial interest.

**9. Appendix D, Web3D 2007 Symposium Call for Participation**

The Web3D 2007 International Symposium will address a wide range of topics about 3D and Multimedia on the Web Topics include languages, tools, rendering techniques, human-computer interaction, mobile devices and innovative applications. As in previous years, this event will be sponsored by ACM SIGGRAPH and held in cooperation with both EuroGraphics and the Web3D Consortium.

**10. List of References**

A partial list of relevant references.



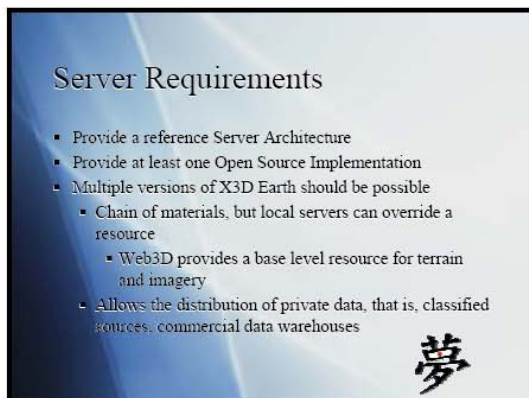
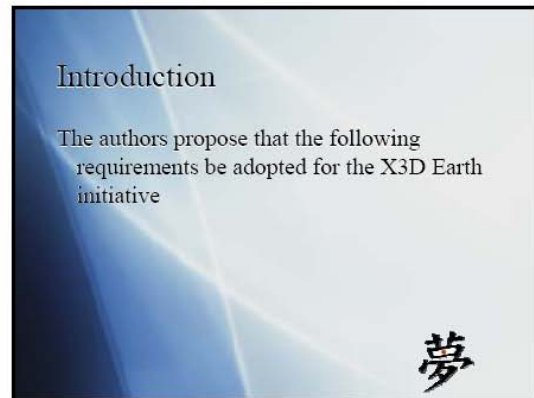
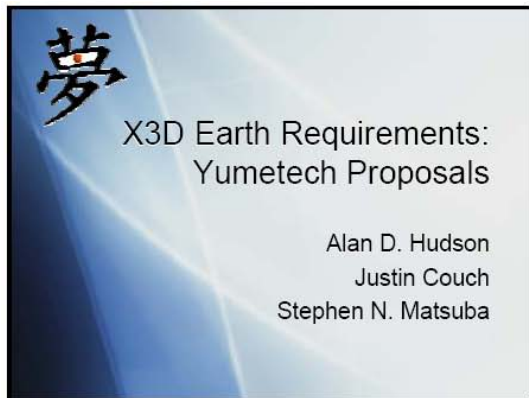
## **II. CONTRIBUTOR PRESENTATIONS**

### **A. INTRODUCTION**

This chapter contains slideset presentations given by each contributing participant. Each presentation is reproduced here by permission. Presentations are also available directly from the X3D Earth Working Group website, online at [www.web3d.org/x3d-earth](http://www.web3d.org/x3d-earth).

## B. X3D EARTH REQUIREMENTS: YUMETECH PROPOSALS

by Alan Hudson, Justin Couch, and Stephen N. Matsuba, [Yumetech](#)



## World State

- Provide a mechanism for distributing world state
  - Example: Is a light turned on?



## Chat System

- Chat areas divided by some mechanism—perhaps regional divisions.



## Display of Volume Data Registered to Terrain Data

- ISSUE: How to render geospatial correct, typically a cube but needs be a frustum?
- NASA Use Case: Underground scans for possible moon base
- Planet 9 Use Case: Animated weather/dispersion display from simulation in a city



## Community-Provided Object Authoring

- Provide an easy art path for users to create content
- Voting System to bring best assets up / avoid spam
- Multiple overlays of data/objects can be subscribed by user
  - Enable data vendors for overlays like 3D Buildings, GIS information



## Enable Client Implementers to Differentiate Themselves

- By how well a layer is rendered?
  - For example, tree coverage (color, texture map, 3D objects)
- Could have conformance issues.



## Enable Multiple Planetary Bodies to Be Viewed

- Up to the Solar System scale
- NASA Use Case: Be able to show a complete earth to mars mission
- Show exploration missions on asteroids as well for mining



## User Selectable Truth or Synthetic View of Data

- Any derived visualizations should be controllable by the user so the raw data can be seen



## Data Fusion

- Easy to combine multiple data sources on top of the world
- GeoRSS overlay is a good example
- WMS/WFS/WCS Support
- Positioning of GeoTIFF files
- KML file display?
- Can either directly support some of these or make sure the API's make it easy
- Ability to import/merge DWG and IFC files
- This might be a conversion to X3D or directly mining



## Ability to Represent Building Internals



## Semantically markup items to enable smarter agent behaviors

- Example: denote what are doors/windows/stairs
- We are not sure what ontologies to use
- Should we create as a layer so the client can request different versions?



## Question to be Considered:

*Should the streaming function be streaming earth or a more generic technology for streaming geometry and textures.*



## Contact

Yumetech, Inc.  
Seattle, WA

Alan Hudson: [giles@yumetech.com](mailto:giles@yumetech.com)



## C. X3D LARGE SCALE TERRAIN RENDERING EXTENSIONS

by Alan D. Hudson, Justin Couch and Stephen N. Matsuba

### Abstract

Traditional X3D modeling is not well suited for large-scale geometry modeling where the entire model contains gigabytes of data. This paper proposes a set of nodes that extend the existing geospatial component to add the ability to stream geometry to the scene based on the user's current position, allow for dynamic and configurable displays based on the available source(s) while providing the browser vendor the opportunity to implement highly efficient terrain-specific rendering capabilities.

### Background

Large scale terrain rendering requires a very different set of tactics compared to the traditional X3D model. In the traditional model, all the data to be rendered is directly contained in the file and any referenced files (e.g. inlines, textures etc). Once the file is read, everything is known. In the geospatial world, this can potentially lead to unmanageable file sizes in the order of terabytes. Just downloading the file itself could take hours or days. Those large files provide all the data, but in reality, the rendering only makes use of a very small subset of it at any one time.

In traditional 2D applications rendering of large-scale terrain data is handled by a very specialised application called a Geospatial Information System, or more commonly known as a GIS. A GIS is responsible for all the terrain management tasks, such as reading the files into memory, stitching maps together, filtering geolocated points of interest based on user-set filters as well as level of detail management. For example, when up in space, sub-meter resolution data is more dense than the pixels on screen and thus it is pointless requesting and using it. The GIS will filter the data to an appropriate level, handing it to the user's application to render. A GIS may also be embedded directly into the application as the primary drawing surface. Some GIS systems have their own 3D renderer, so for the purposes of this paper, we will ignore this functionality as it is not relevant to the X3D market.

In the 3D world, there are at least half a dozen commonly used rendering techniques for large scale terrains. Each technique requires the underlying data to be fetched in its own unique form. A simple grid of data points like an ElevationGrid is not always the most suitable way for these rendering engines to work. In addition, the level of information needed for collision detection of objects with the terrain is different to the detail needed for the terrain rendering itself. Each of these requests can be localised, greatly reducing the amount of data that needs to be fetched over the network.

All of these requirements point to the need for X3D to evolve a system where it must be able to handle streamed data, yet maintain compatibility with X3D's traditional design philosophy. The design of such a system should also support the browser being able to scale the content's detail based on the individual system that it finds itself installed on. While the content developer has the option of asking and instructing the browser on the type(s) of content to display, the browser has the option of filtering it in order to

maintain a reasonable level of performance for the chosen terrain rendering implementation.

## Concepts

We start with the basic premise that in any form of rendering, the closer you are to an object, the more detail that is desired – the currently bound viewpoint defines the center of the highest detailed information to be displayed within that layer. This information is used by the browser implementation to interact with the underlying geospatial data source to access the appropriate amount and detail of data.

The browser fetches information based on the location of the currently bound viewpoint. A browser shall be capable of using both GeoViewpoint and Viewpoint as input for determining what data needs to be fetched and according to its specific rendering strategy. In addition, it may use elevation information to control the level of detail of information that it retrieves and renders. For example, being in space may only require 100Km resolution data, but on the ground would use 1m data. The browser is free to choose the level of detail it feels is appropriate to the location of the currently bound viewpoint, while also attempting to fulfill the requested minimums of the user. This requirement does not require the browser to use this resolution to the full visible limit. Most geospatial rendering algorithms selectively filter data to reduce resolution the further away it is from the current viewing location. This requirement only applies to the near-field viewing.

These nodes do not define a GeoOrigin like their non-streamed relatives. As data is brought into the system, the position of the viewer is defined to be an implicit GeoOrigin, so that calculations are always most accurate around the current camera position. This will reduce many of the jitter problems that can become apparent in the existing geospatial nodes when navigating far from the GeoOrigin that was encountered when the user first loaded the world.

The user may optionally provide advice on the minimum acceptable data resolution and bounds. When the data source is capable of providing data of at least this resolution, then the browser shall be required to fetch and render data of at least that resolution. However, it is acknowledged that not all data sources are equal and sometimes data may be available, but at a lesser resolution than that requested. When this is the case, the browser may ignore the minimum requirements and fetch the best resolution data that it can access. Some data rendering at a lower resolution is always to be considered better than none at all.

The spatial area covered by the data should be determined by the browser, but informed by hints on the node. When the user does not provide any hints, then the browser should use the visibility limit of the currently bound NavigationInfo to set the bounds of data that should be rendered. It is expected that the browser will typically have more data beyond this limit as part of its internal caching strategy for high performance rendering engine, this is just about defining the currently visible limits. If the visibility limit is set to infinite, the browser is free to choose its own bounds (within reason) based on the performance criteria hints that the user may provide.

Geospatial sources of data represent their contained data in one of two forms – bitmaps or vectors. Bitmap data is used to cover every section of the nominated space

with some form of meaningful data. The most common example of this is vegetation data. Each pixel of the bitmap corresponds to a vegetation type at that given grid square (where the size of the grid square is a property of the underlying data source). Vector data is used to represent information that only travels between given points. Examples of data in this form are political boundaries and road centerlines. A 2D rendering of this information typically does not allow for much stylistic variance. The 3D world, however, has many different ways of rendering them. Vegetation information may be rendered as the raw bitmap, a set of splatted textures, fixed 3D models or an intelligent modeling algorithm. Which of these options to use is highly dependent on the individual user's machine. A really fast machine could easily handle the full 3D geometry, but an old, obsolete machine would barely be able to handle a simple textured model. To cater for both ends of the spectrum, this proposal takes the approach of not letting the content author explicitly state what to use, only to provide performance hints to the browser. With geospatial rendering, it is trivially easy to grind an end-user's computer to a standstill with very simple bad design choices that “works OK on my computer”. Here we make use of the X3D design philosophy of letting the end user choose what works best for them, not what the content author forces them to have.

### **Browser Hint Properties**

Despite allowing the browser almost full control over what is being rendered, the user still needs the ability to give the browser hints about what is considered the preferred optimisation strategy. One application may want to focus on speed, another on detail etc.

A new browser property is defined that can be used, along with the given sets of values:

GEOSPATIAL\_RESOLUTION: "SPEED", "DETAIL", "FIXED\_FRAME\_RATE"

Optimisation for speed tells the browser that it is OK to drop spatial resolution in order to keep the frame rates as high as possible. It is mostly likely that the browser will only use the minimum resolution terrain data sources and not provide any detailed model rendering.

Optimisation for detail tells the browser to favour using 3D models for the overlays rather than simple lines and textures. Terrain detail nearest the viewpoint will be higher, and the detail falloff will be further from that location.

Optimisation for fixed frame rates allows the browser to raise and lower the detail levels so that a constant frame rate is achieved. Typically this is used in simulator-style or immersive systems where the goal is to render at a constant frame rate, such as 30 frames per second.

### **Nodes and Abstract Data Types**

The following collection of nodes and abstract data types are proposed to provide streamed geospatial extensions. These nodes would be added as part of the Geospatial Component at level 2.



```

X3DGeospatialStreamedObject {
    SFFloat  [in,out] minimumResolution  0          [0,∞)
    MFString []      geoSystem           [ "GD", "WE" ] [see 25.2.3]
    SFString []      dataType            " "         [ "VECTOR" | "RASTER" |
.... ]
    SFString []      layerType            " "
    MFString []      source               [ ]
}

```

A streamed object provides data to the rendering system on the fly as the content is being rendered. It does not specify the protocol, method or strategy to be used to fetch this data. The browser implementation chooses a method appropriate to the source and its own implementation of large-scale terrain rendering strategies. For example, if a browser implements the ROAM strategy then it would need to interact with the underlying source as sets of tiled data, while using a CLOD strategy would require a continuous stream of input.

The `dataType` field defines the type of data that can be expected from this streamed source. It allows the containing node to decide whether this source is applicable to its use. For example using raster data as an input for an indexed line set's Coordinate node would not be useful or usable. Two types are defined for the value, with other options available on an implementation-specific basis:

“VECTOR” represents streamed data as 3D coordinates.

“RASTER” represents streamed data as pixel data in a rectangular grid.

The default value for this field is set by the concrete node definitions.

The `layerType` field provides an informative description of the data that this source represents. It could be used in a user interface or just as a unique way of identifying the specific data to be used. In addition, the browser implementation may choose to apply additional semantics based on this layer definition. For example it may choose to render vegetation data using 3D models rather than just as a raster overlay. River or road data may be treated in a similar fashion. If the browser chooses to interpret this field in this way then it is recommended that user interface options as well as browser options be provided to select which to show. The following type values are defined to have specific meaning:

```

"Vegetation",
"RoadCenterLine",
"River",
"CoastLine",
"Powerline",
"Political",
"NationalBoundary",
et cetera.

```

The `source` type string lists a section of source locations that this content recommends fetching data from in order of preference. The protocols used to request and



interpret the returned data are not specified. The browser may choose to use all sources in order to fulfill the requests. Each source may only have information from a specific part of the world, so a browser is free to pull data from any source in order to fulfill the required data information. A special URL protocol—"localgeo"—states that the browser may optionally choose to fetch the data from any local source or other internal implementation-specific source that it knows it has access to.

The `minimumResolution` field defines the user-required minimum data resolution to be rendered. The resolution is specified in meters. A value of zero states that the user does not care what is available and the browser is free to choose a resolution based on some implementation-specific reasoning.

```
GeoStreamedOverlay : X3DNode, X3DGeospatialStreamedObject {
    SFBool    [in,out] enabled          TRUE
    SFNode    [in,out] metadata        NULL          [X3DMetadataObject]
    SFFloat   [in,out] minimumResolution 0             [0,∞)
    MFString  [in,out] stylePreference  ""
    [ "CENTERLINE", "MODEL", "DECAL" ]
    SFString  []      dataType          "RASTER"      [ "VECTOR" | "RASTER" |
.... ]
    MFString  []      geoSystem         [ "GD", "WE" ] [see ISO 19775-1, Part 1:
25.2.3]
    SFString  []      layerType         ""
    MFString  []      source            []
}
```

This node represents one of the overlays that are available to be rendered. Typically this node will be generated as output from the `GeoSourceManager` and then passed directly to the `GeoStreamedElevationGrid`. The `enabled` field defines whether this overlay should be currently rendered. Data can still be fetched, but rendering is not performed.

The `stylePreference` field defines the user-preferred rendering style to be used for this layer, in order of preference. For example, this may be used to instruct the renderer to take road centerline vector data and render it as a decaled texture over the terrain rather than just a line set describing the centerline. Three values are defined by the specification. Implementations are permitted to provide other values.

"CENTERLINE": Render the data as a set of line. Only applicable if the data type is vector. Has no meaning for raster data.

"MODEL": Render the data as full 3D models. For example, vegetation raster map is turned into algorithmically generated tree, grass and flower models.

"DECAL": Lay the data over the base elevation grid as a decaled texture.

Vector data has an appropriate image selected, raster data is directly mapped using an implementation-specific technique.

```

GeoStreamedCoordinate : X3DCoordinateNode,
                        X3DGeospatialStreamedObject {
SFNode    [in,out] metadata      NULL      [X3DMetadataObject]
SFFloat   [in,out] minimumResolution 0        [0,∞)
SFString  []      dataType       "VECTOR"    ["VECTOR" | "RASTER" |
.... ]
MFString  []      geoSystem      ["GD","WE"] [see ISO 19775-1, Part 1:
25.2.3]
SFString  []      layerType      ""
MFString  []      source         []
}

```

This node describes a set of streamed geospatial coordinate data. It can be used as input for standard geometry such as line and triangle sets. The geometry values are provided based on the user's current location.

When using this node, it is recommended that all other geometry input is not provided and the default automatically generated normals, colors and texture coordinates are used. If these other fixed types are used, the behavior is undefined.

```

GeoStreamedElevationGrid : X3DGeometryNode,
                          X3DGeospatialStreamedObject {
SFBool    [in,out] enableBase     TRUE
SFNode    [in,out] metadata      NULL      [X3DMetadataObject]
SFFloat   [in,out] minimumRange   0        [0,∞)
SFFloat   [in,out] minimumResolution 0        [0,∞)
MFNode    [in,out] overlays       []        [GeoStreamedOverlay]
SFDouble  []      creaseAngle     0        [0,∞)
SFString  []      dataType       "RASTER"   ["VECTOR" | "RASTER" |
.... ]
MFString  []      geoSystem      ["GD","WE"] [see ISO 19775-1, Part 1:
25.2.3]
SFString  []      layerType      ""
MFString  []      source         []
}

```

This node represents an elevation grid that sources its geometry from an external stream. Resolution, normals and texture coordinates are assumed to be calculated on the fly. Although this method can work with the normal appearance nodes, it is most likely that it will be better to use the overlay capability to provide the dynamic streamed texturing rather than rely on an external mechanism.

The overlay field defines the current set of geometry that can be rendered over the top of the elevation as decals. The declaration order defines their rendering order. Index 0 is rendered closest to the terrain, and index n is rendered furthest from the terrain.

The creaseAngle field is used to determine when to smooth shade or hard edge, as per the other geometry types.

The minimumRange field defines the minimum acceptable viewable distance that the user wishes to have. It also defines a linear distance in the local ground plane coordinates axes from the user's current location. If this value is less than the visibilityLimit of the currently bound NavigationInfo, then the browser may use this value to guide how much terrain geometry needs to be loaded and managed. If this value is greater than the current visibilityLimit, then it may be ignored by the browser. This defines the minimum range, so that if the browser determines that it can support greater distance, it may choose to render more terrain than is suggested by this. Unless there is no

underlying data available, the browser shall always render at least this amount of geometry.

```

GeoSourceManager {
    SFNode    [in,out] metadata    NULL          [X3DMetadataObject]
    MFString  [out]    layerTypes
    MFString  [out]    dataTypes
    MFString  []       source      []
}

```

This node represents the information that the browser is able to determine from the provided sources. This can be used by application code to configure on the fly what the user can build in their world. For example, a script could be written that queries this manager output and uses it to configure the overlays.

```

GeoDragSensor : X3DDragSensorNode {
    SFBool    [in,out] autoOffset    TRUE
    SFString  [in,out] description   ""
    SFBool    [in,out] enabled       TRUE
    SFNode    [in,out] metadata      NULL [X3DMetadataObject]
    SFBool    [out]    isActive
    SFBool    [out]    isOver
    SFVec3f   [out]    trackPoint_changed
    SFVec3f   [out]    trackNormal_changed
    SFVec3d   [out]    hitGeoCoord_changed
    SFNode    []       geoOrigin      NULL          [GeoOrigin]
    MFString  []       geoSystem      ["GD","WE"] [see ISO 19775-1, Part 1:
25.2.3]
}

```

This node creates a drag sensor that follows the surface of the underlying terrain. When a drag is in progress, the output is determined by the intersection point of the terrain and the input device. The normal output is the surface normal at that intersection point.

The autoOffset field is ignored for this node as it is derived from the X3DDragSensorNode definition.

trackPoint\_changed will generate something in the local 3D coordinate that has no geospatial reference. However, the authors feel that it is odd to have this component with these geospatial nodes as it is on GeoTouchSensor.

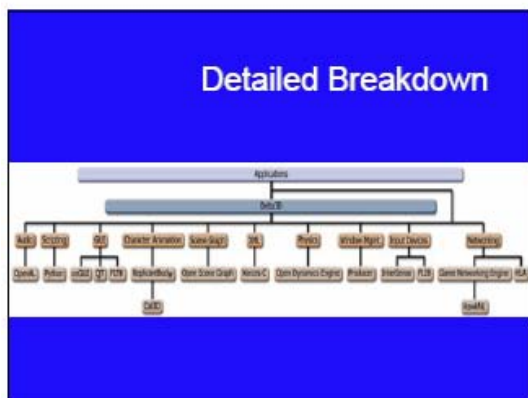
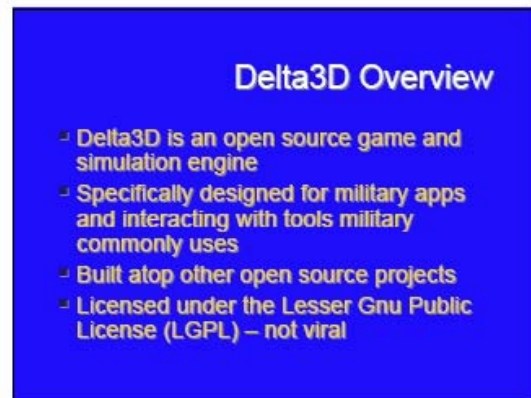
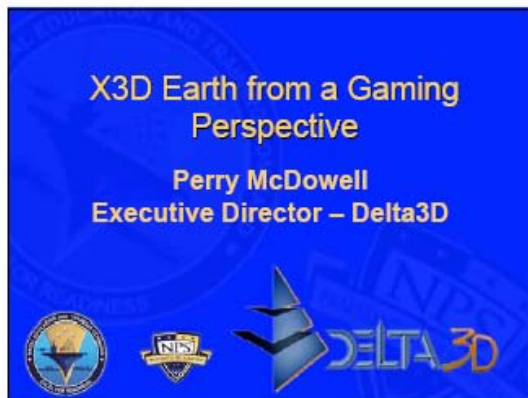
geoOrigin is provided for compatibility with the fixed geospatial nodes. Perhaps we could modify Level 1 to add this node since it is not required for streaming capability.

## Closing Remarks

This proposal defines a set of nodes and concepts that allow for streaming geospatial data to a scene. It strikes a balance between content author configurability, end user system capabilities and the browser implementation burden. It explicitly avoids definition of networking protocols or interactions between the browser and the underlying data source of the geospatial data. There are many potential options for this capability, both open standards and proprietary, and thus the realm of a separate discussion.

## D. X3D EARTH FROM A GAMING PERSPECTIVE

by Perry McDowell, [NPS](#)



Delta3D Summary	
<b>Features</b> <ul style="list-style-type: none"> <li>OpenGL 2.0 rendering</li> <li>Character animation</li> <li>Realistic physics</li> <li>Hi-level classes (rapid development)</li> <li>2D/3D audio</li> <li>Multiple file formats</li> <li>Python scripting</li> </ul>	<ul style="list-style-type: none"> <li>Game manager control</li> <li>Multiple terrain rendering methods</li> <li>Particle systems</li> <li>HLA and game networking</li> <li>Advanced environments</li> <li>Abstracted input devices</li> <li>Record/playback</li> <li>Licensed under LGPL</li> </ul>
<b>Content Creation Tools</b> <ul style="list-style-type: none"> <li>STAGE</li> <li>3D model viewer</li> <li>Graphical particle editor</li> </ul>	<ul style="list-style-type: none"> <li>No licensing costs</li> <li>Cross platform compatible</li> <li>Maintained by a dedicated team</li> <li>User support forums</li> </ul>



## Terrain

- Delta3D has several ways to generate terrain
  - Directly from DTED data using CLOD
  - Procedural infinite terrain
  - Generating Enhanced Natural Environments and Terrain for Interactive Combat Simulations
    - GENETICS

## GENETICS



## Gamers Needs from X3D Earth

## Basics

- Ground clamping
- Collision detection
- LOS determinations
- Adding geometry to scene
  - Support all common file formats

## Pipeline

- The pipeline is how a game goes from the designer's brain into the gold master
- Most consider it the number one determining factor of whether a game is on time, on budget, or even completed
- Must be easy, fast and user friendly to make changes to the game

## STAGE



### Military Specialties

- Deformable terrain
- Material features (easily determined)
  - Surface characteristics
- IR/Near IR Terrain characteristics
  - Data storage
- Physical properties

### Point of Contact

Perry McDowell  
MOVES Institute  
(831) 656-7591  
[mcdowell@nps.edu](mailto:mcdowell@nps.edu)  
<http://delta3d.org>

## E. X3D / XJ3D USAGE FOR BATHYMETRIC RENDERING IN BATTLESPACE MANAGEMENT

by Doug Maxwell, [Naval Undersea Warfare Center \(NUWC\)](#), Newport RI

**X3D / Xj3D Usage for Bathymetric Rendering in Battlespace Management**

Douglas Maxwell, MSME  
[maxweldb@npt.nuwc.navy.mil](mailto:maxweldb@npt.nuwc.navy.mil)  
Naval Undersea Warfare Center Division Newport (NUWCDIVNPT)  
11.13.06

**Workshop Goals**

- NUWCDIVNPT X3D Usage
  - Antisubmarine warfare battlespace visualization
  - Includes air, surface, subsurface assets
  - Visualization of weapon placement
- Discuss current state
  - Current bathymetric content
  - Tristrips and Elevation Grids
- Discuss planned upgrades/enhancements
  - Transition to Geo-Elevation Grids
  - Constraints

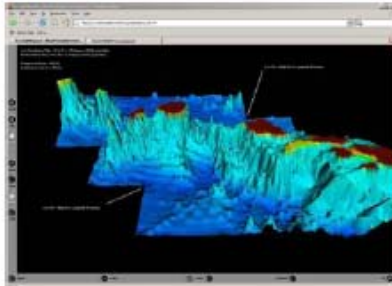
**Web3D Usage for Distributed Battlespace Management**

In late 2004 Naval Undersea Warfare Center investigated the feasibility and level of effort required to develop a lightweight 3D replay capability using X3D technology.

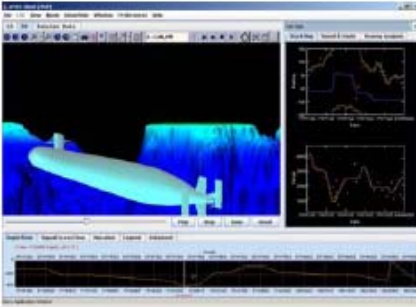
The investigation focused on 3 factors:

- data retrieval from a consolidated database of fleet exercises and events
- integration of bottom bathymetry anywhere on the planet
- performance

**Screenshots**



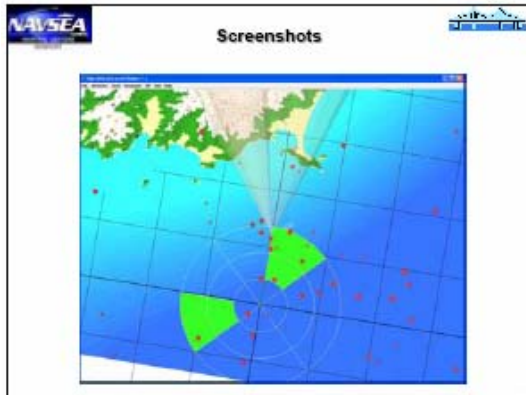
**Screenshots**



**Screenshots**







**NAVSEA** **Bathymetry – Grid Derivation**

DWC based bathymetry grids are generated using NUWC/NRL based Inverse Distance Weighted (IDW) algorithm.

IDW is tunable based on number of surrounding data points used to generate vertices and grid density. Creates homogenous output.

DWC based bathymetry is generated by accessing proprietary API. X3D files are assembled after raw dump.

$$z_p = \frac{\sum_{i=1}^n \left( \frac{z_i}{d_i} \right)}{\sum_{i=1}^n \left( \frac{1}{d_i} \right)}$$

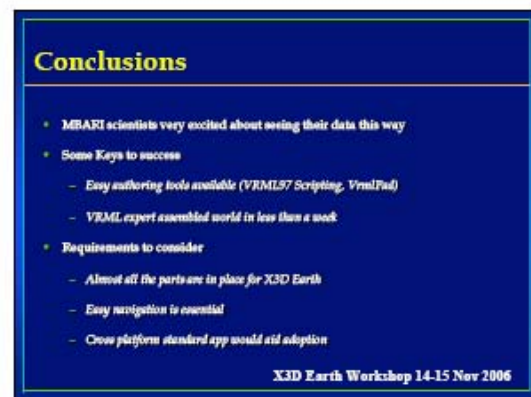
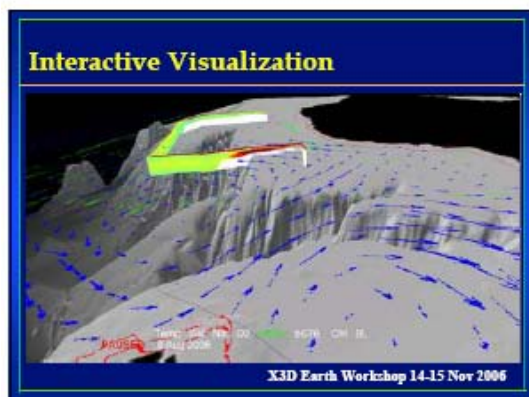
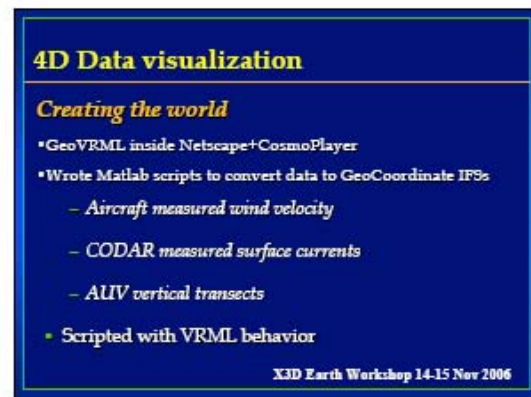
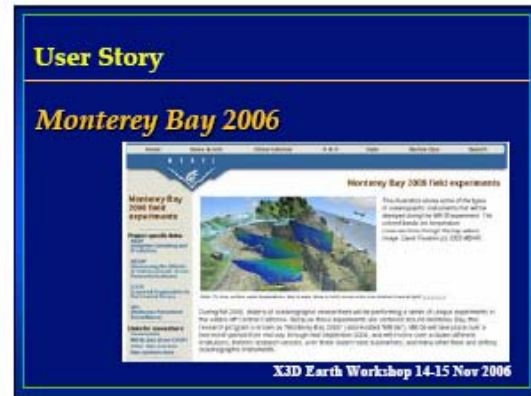
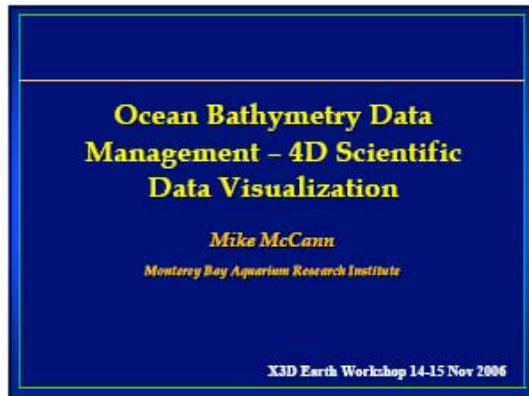
**NAVSEA** **Standardization and Conventions**

- Level of Detail
  - Do we page in differing X3D bathymetric models with varying grid densities?
  - Textures
- X3D data structures
  - Does it make sense to have separate elevation/geo-elevation grid libraries?
- Meta data
- Approved gridding methods?



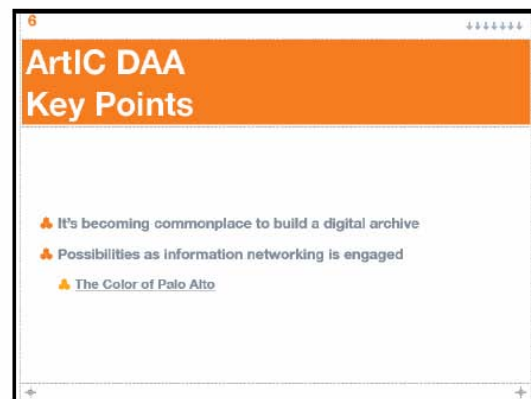
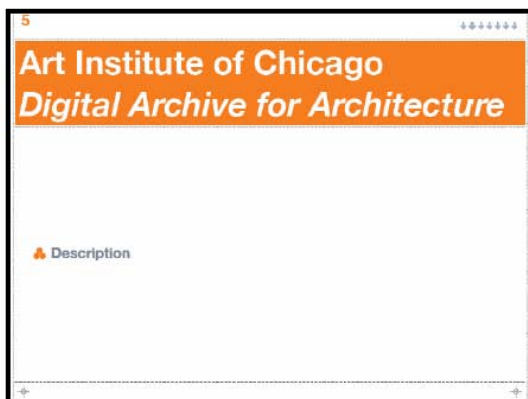
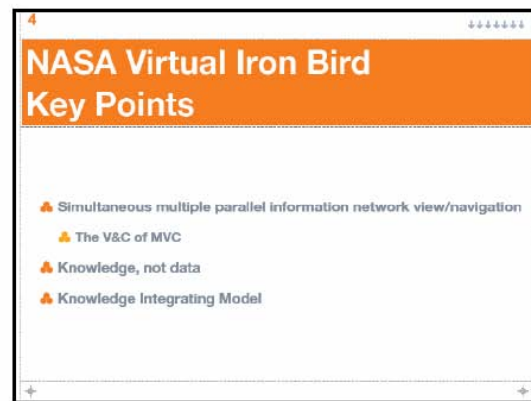
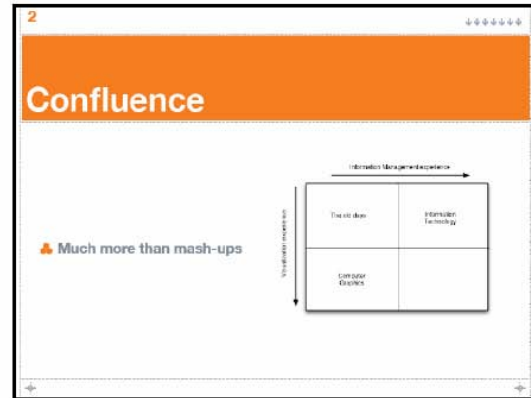
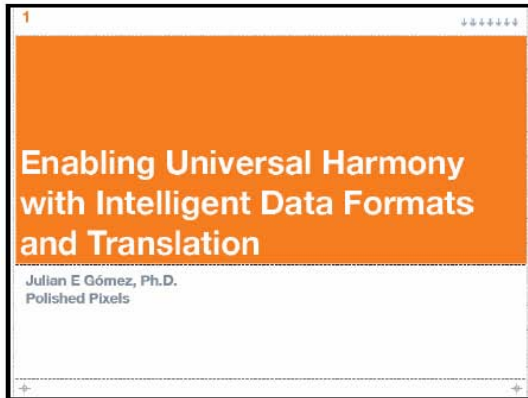
## F. OCEAN BATHYMETRY DATA MANAGEMENT – 4D SCIENTIFIC DATA VISUALIZATION

by Mike McCann, [MBARI](http://mbari.org)



## G. ENABLING UNIVERSAL HARMONY WITH INTELLIGENT DATA FORMATS AND TRANSLATION

by Julian E. Gomez, Ph.D., [Polished Pixels](#)



7

Takeaways

The 21st century is about information

It will come from everywhere and be functionally combined for the context

You call that a data warehouse? That's not a data warehouse, mate.  
*THIS* is a data warehouse.

Enabled by data standards and intelligent translation

Frameworks will make it accessible and extensible

## H. X3D AUGMENTATIONS FOR GENERAL SPATIAL REFERENCING AND X3D & SEDRIS

by Richard F. Puk, Ph.D., [Intellgraphics](http://Intellgraphics.com)

**Intellgraphics**  
Incorporated

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### X3D & SEDRIS—Together

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X3D Earth Requirements Workshop  
November 14 & 15, 2006  
Monterey, California

By

Richard F. Puk, Ph.D.  
Intellgraphics Incorporated

**Intellgraphics**  
Incorporated

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### X3D Standards

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- ISO/IEC 19775—X3D
  - Part 1: Architecture and base components
  - Part 2: Scene access interface (SAI)
- ISO/IEC 19776—X3D encodings
  - Part 1: XML
  - Part 2: Classic VRML
  - Part 3: Compressed binary
- ISO/IEC 19777—X3D language bindings
  - Part 1: ECMAScript
  - Part 2: Java

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### SEDRIS Standards

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- ISO/IEC 18023—SEDRIS
  - Part 1: Functional specification
  - Part 2: Abstract transmittal format
  - Part 3: Transmittal format binary encoding
- ISO/IEC 18024-4—SEDRIS binding to C
- ISO/IEC 18025—Environmental data coding standard (EDCS)
- ISO/IEC 18026—Spatial reference model (SRM)
- ISO/IEC 18041-4—EDCS binding to C
- ISO/IEC 18042-4—SRM binding to C

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### Spatial positioning

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- Limited support in X3D using the current Geospatial Component
- Wide support in the SRM as specified in ISO/IEC 18026

PROPOSAL: Map the missing capabilities to X3D either as an enhanced Geospatial Component or as a separate more general Spatial Component

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### X3D Geospatial Component

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- Supports some geodetic, geocentric, and universal transverse Mercator SRFs
- Supports 23 Earth ellipsoids
- Supports WGS84 Earth geoid
- 10 nodes to express geolocated material and interaction

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### SRM Capabilities

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- 28 types of abstract coordinate systems
- A variety of reference datums, embeddings of position-space into object-space, and object reference models
- 27 SRF templates, 14 pre-defined SRFs, 7 SRF sets (incl. UTM) with standard parameterizations
- Operations between applicable SRFs
- Support for spatial operations on non-Earth celestial bodies including most solar system objects
- Algorithms provided to ensure accurate processing of spatial data

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## Spatial positioning

- Proposed requirements:
  - X3D should be able to handle any SRF natively
  - X3D should integrate the functionality of the SRM
- Anticipated benefits:
  - Minimize the need to convert input data from one SRF to another
  - Ease of integrating environmental data sets

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## Metadata

- General support for metadata in X3D but no specific metadata standard required
  - EDCS standardizes the identification of objects and properties and can be extended
- PROPOSAL: For X3D Earth, require metadata to use EDCS to standardize metadata easing interpretation

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## X3D Metadata Support

- General metadata support
- Metadata accessible during run-time
- Metadata can be applied at any level to any X3D node
- Specific metadata standards can be cited
- X3D Metadata fields:
  - name: identifier for value
  - reference: applicable metadata standard
  - value: value for metadata
  - metadata: metadata nodes can have metadata

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## EDCS

- Set of dictionaries with entries containing:
  - Concept definition
  - Label
  - Code
  - Reference type and reference
  - Other dictionary-dependant information
- Nine dictionaries:
  - Classification
  - Attribute
  - Attribute value characteristic
  - Attribute enumerator
  - Unit
  - Unit scale
  - Unit equivalence class
  - Organization schema
  - Group

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## Metadata

- General support for metadata in X3D but no required standard
  - EDCS standardizes the identification and properties of objects
- PROPOSAL: Require the use of EDCS for identifying and propertizing objects in X3D Earth

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## Summary

- X3D Earth should require complete access to spatial data capabilities standardized in the Spatial Reference Model. This will require upgrading the current X3D Geospatial Component.
- X3D Earth should require use of EDCS for specifying the identification and properties of X3D Earth objects.

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## Where to get standards

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- X3D
  - <http://www.web3d.org/x3d/specifications>
- SEDRIS
  - <http://standards.sedris.org/>



## **I. X3D AUGMENTATIONS FOR X3D GENERAL REFERENCING**

by Richard F. Puk, Ph.D., Intelligraphics, Inc.

### **Abstract**

X3D is already capable of presenting geo-spatially referenced data. However, these capabilities are somewhat rudimentary and can be significantly improved. This white paper describes how the spatial referencing of X3D can be generalized through adoption of recently approved SEDRIS standard technologies.

### **Introduction**

X3D Earth is a project that is intended to make spatial data residing in publicly available databases easily accessible. One goal of this project is to use International Standards that support the project and that also do not have significant intellectual property rights restrictions. X3D is the name given to one such set of standards. Another set of standards are those that specify SEDRIS technologies. This paper will describe how the SEDRIS technologies may be used to augment X3D with general spatial referencing capabilities as well as providing the means whereby metadata information can be integrated into X3D worlds in a standard manner.

### **Relevant Standards**

#### ***X3D Standards***

The moniker, X3D, stands for Extensible 3D. The set of X3D standards specifies a representation and run-time environment for presenting dynamic 3D data. ISO/IEC 19775 is a two-part standard that specifies an abstract representation mechanism for describing 3D worlds and for accessing those worlds from external programs. Part 1 is a specification of the abstract description of the X3D architecture and description mechanism. Part 2 is a specification of the Scene Access Interface that defines a set of services which can be accessed either from within an X3D world or from external programs. These services can be used to modify the world as it runs.

The X3D Architecture divides X3D functionality into a set of components. Each component specifies the capabilities for a particular type of functionality. For example, the Geometry3D Component describes 3D geometry nodes and the Navigation Component specifies the viewing and navigating functionality with X3D worlds. There are currently 40 components that are either standardized or in the process of being standardized. Historically, X3D is a 2<sup>nd</sup> generation standard that improves upon the Virtual Reality Modeling Language (VRML) which was standardized as ISO/IEC 14772. Both VRML and X3D are widely used throughout the world.

The set of abstract nodes and fields described in Part 1 of the X3D standard can be represented in files by encoding the abstract descriptions using various encoding techniques. ISO/IEC 19776 is a three-part standard that describes three different interchangeable encoding techniques: XML, Classic VRML, and Compressed Binary. Any X3D file can be encoded in one and converted to another without loss of information. In addition, X3D browsers that implement more than one encoding technique can intermix the X3D content that use differing encoding techniques. Additional techniques can be added by standardizing additional parts of ISO/IEC 19776.

The services specified abstractly in Part 2 of X3D can be utilized from different scripting languages. ISO/IEC 19777 is a two-part standard that specifies language bindings for the abstract services. Part 1 specifies a binding to ECMAScript while Part 2 specifies a binding to Java. Other languages can be supported by standardizing additional parts of ISO/IEC 19777.

There are no IPR restrictions imposed by the X3D standards.

### ***SEDRIS Standards***

SEDRIS is a set of standards for representing accurate descriptions of real or virtual spatial environments. SEDRIS does not specify a run-time environment. Instead, it supports the precise and standard description of spatial environments for use in simulations. The goal of SEDRIS is to allow the reuse of these spatial environments on differing simulation systems. The SEDRIS technologies consist of a Data Representation Model (DRM), an Environmental Data Coding Standard (EDCS), and a Spatial Reference Model (SRM). The latter two standards are defined generally so that they can be used either by the DRM or by other non-SEDRIS applications.

EDCS is standardized in ISO/IEC 18025 and specifies a standard set of codes for representing various concepts. For example, there is a standard code for representing a school building. This allows anyone who reads the code to understand that the associated data represents a school building. There are codes for such concepts: as *classifications* (what does the data describe), *attributes* (what are the properties of the object and what are the values for those properties), and *units* and *unit scale factors* (in what units is the object specified). Other codes are specified for working with these fundamental codes. Each concept is assigned a standard name, a standard code, and other information including descriptions, source references, and related information.

SRM is standardized in ISO/IEC 18026 and specifies a standard reference model for specifying spatial data. The SRM not only specifies the means for specifying such data but also the algorithms for implementing those specifications. In addition, names and codes are assigned for representing well-known and accepted celestial objects such as the planets, moons, and the sun. The SRM is especially valuable in that it collects in a single document information that has heretofore only been available in source material



that is often hard to find or, once found, hard to obtain. The concepts supported by the SRM include the specification of Spatial Reference Frames and Object Reference Models. The current X3D Geospatial Component uses a very small and limited subset of the information specified by the SRM.

The SEDRIS DRM is standardized in ISO/IEC 18023 and specifies a standard mechanism for representing spatial environments. The DRM is actually a mechanism for specifying the characteristics of data models and populating those data models. An instance of a populated data model is termed a transmittal in this standard. Part 1 of the SEDRIS standard specifies an abstract description of the capabilities of the DRM. Also specified is an abstract specification of functions for creating and accessing transmittals and the constituent DRM elements of that transmittal. Parts 2 and 3 specify an abstract transmittal file format and a particular binary encoding for transmittals. It is intended by this standard that transmittals be an interchange mechanism for environmental data which, to be utilized, needs to be imported into a simulation system for processing.

Each of the abstract standards described above have an associated standard binding to the C programming language.

The SEDRIS Organization is comprised of SEDRIS Associates representing a variety of organizations whose goal is to support the SEDRIS standards either as users or as product developers. One SEDRIS associate is ObjectRaku of Vancouver, BC. ObjectRaku is a company that supports SEDRIS and VRML for a variety of mostly military projects. Since they already support both SEDRIS and the X3D predecessor, it might be worthwhile inviting them to join the X3D Earth project.

There are no IPR restrictions imposed by the SEDRIS standards.

## **Integration of SEDRIS technologies within X3D**

### ***SRM Integration***

X3D already supports a very limited subset of the SRM. While this does allow geopositioning objects within an X3D world, it falls far short of supporting standardly available environmental data. For example, only one form of geodetic and one form of geocentric spatial reference frames are supported. Moreover, it is not generally possible to integrate environmental data specified in more than one SRF. The proposal is for the X3D Geospatial Component to be either enhanced to support all of the capabilities of the SRM or to specify a new X3D Spatial Component that supports the entirety of the SRM. Further research is needed to determine the best course. It should be noted that the entirety of the SRM has been implemented in an open source implementation available at <http://www.sedris.org>. In addition, there are many commercial implementations of the functionality. Thus, the time-consuming and

expensive job of implementing the algorithms is not needed. However, the means of specifying the requisite parameters within X3D remains.

### ***EDCS Integration***

The information provided by EDCS can be considered metadata for most applications. X3D already has a powerful and flexible metadata capability that allows metadata to be specified at any level and according to any metadata standard. Anyone wishing to use EDCS code in X3D worlds need only include the codes in the appropriate X3D metadata nodes. This should be encouraged as it does provide for a standard meaning to the metadata. The only area in which EDCS might influence the design of X3D is that EDCS allows values to be specified in any of a variety of compatible units. Should X3D desire to support units other than meters and radians, additional fields could be added as appropriate to allow unit and unit scale factor specification. However, this is not currently being proposed for X3D Earth. It should be noted that EDCS units are the units specified by ISO 41 which specifies international standard units.

### ***DRM Integration***

There are currently no plans to integrate DRM functionality into X3D. However, it might be worthwhile to evaluate some of the capabilities of specific DRM classes as a means of augmenting X3D capabilities. An example is that the DRM supports a range of level of detail capabilities in addition to distance LOD.


One SEDRIS-based project that might be worthwhile would be to develop a translator from SEDRIS transmittals to X3D nodes. This would allow for convenient presentation of SEDRIS environments in a wider context.

### **Proposal**

As part of the X3D Earth project, a general enhancement to the X3D Geospatial Component (or an additional Spatial Component) will be necessary to handle the data that exists throughout the world in a variety of SRFs thus avoiding unnecessary SRF conversions and database duplications. In addition, integrating the entirety of the SRM in X3D would also provide support for non-Earth presentations as well as the SRM supports the ability to represent most of the celestial objects in our solar system. Additionally, the X3D Earth project should impose a requirement to use the EDCS to classify features being represented by X3D Earth data. In this manner, worldwide understanding of the meaning of environmental data will be ensured.

## J. X3D EARTH VIEWING AND AUTHORING FOR THE WEB

by Toni Parisi and Keith Victor, [Media Machines](#)



**Media Machines**

X3D Earth Viewing and Authoring for the Web  
November 2006

Media Machines

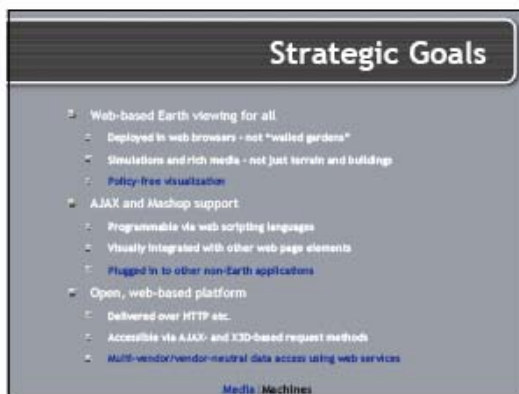


### About Us

- A leading developer of open source web-based X3D products and services
- Web pioneers, long-term VRML and X3D contributors

**Our Mission:**  
To Build the Open Metaverse

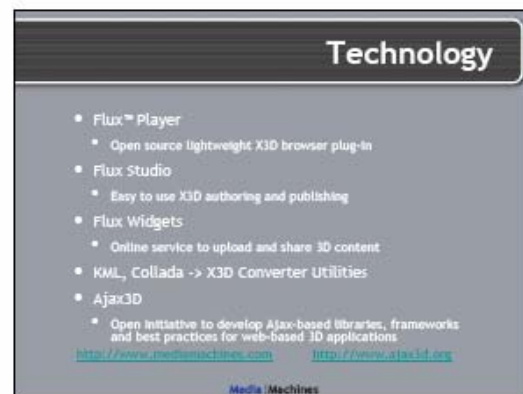
Media Machines



### Strategic Goals

- Web-based Earth viewing for all
  - Deployed in web browsers - not "walled gardens"
  - Simulations and rich media - not just terrain and buildings
  - Policy-free visualization
- AJAX and Mashup support
  - Programmable via web scripting languages
  - Visually integrated with other web page elements
  - Plugged in to other non-Earth applications
- Open, web-based platform
  - Delivered over HTTP etc.
  - Accessible via AJAX- and X3D-based request methods
  - Multi-vendor/vendor-neutral data access using web services

Media Machines



### Technology

- Flux™ Player
  - Open source lightweight X3D browser plug-in
- Flux Studio
  - Easy to use X3D authoring and publishing
- Flux Widgets
  - Online service to upload and share 3D content
- KML, Collada -> X3D Converter Utilities
- Ajax3D
  - Open initiative to develop Ajax-based libraries, frameworks and best practices for web-based 3D applications

<http://www.mediamachines.com> <http://www.ajax3d.org>


Media Machines



### Team

<b>Toni Parisi</b> CEO	Founder/CTO: <b>Intervista Software</b> 20-year Veteran: Linux, BSD, PLATINUM Technology Pioneer: Web, X3D, MPEG-4 Software Architect: Creator of FLUX
<b>Jay Weber, Ph.D.</b> Chief Technology Officer	Founder/CTO: <b>EspeonTV</b> (now part of Thomson) 20-year Veteran: VeriFlow, HP, A Research Technology Pioneer: Web 2.0, ITV, IT patents Award winning container portals experience
<b>Keith Victor</b> VP Tools	3D Modeling/Animation Tools Expert Founder: <b>Virobok Technologies</b> Lead Engineer: <b>Openmatic</b> , <b>General Vector</b> Software Architect: <b>Creator of Space3D, Virobok, Flux Studio</b>
<b>David Arendash</b> Senior Programmer	Senior Programmer/Technical Director Extensive game development experience; expert in connector/reporter tools development and application programming X3D Convention Utilities: <b>OpenE4, 3DS Max, KML, Collada</b>

Media Machines



### Related Projects

- NPS Ariva X3D Earth
  - Assist preparing X3DE Component documentation for Web3D and ISO approval
- Add proven geospatial extensions and X3D-Earth support to open source Flux web browser plug-in
- Extend Flux Studio authoring tool to support proven geospatial extensions and X3D-Earth
- Develop sample lightweight X3DE Global Viewer capable of running in a web page, based on AJAX architecture ("AJAX3D")
- City of St. Paul, MN mapping prototype

Media Machines

## Technical Challenges

- Intuitive earth-based navigation interface
- Multi-resolution terrain rendering
- Data layering - optimizing performance and rendering
- Client-server networking - architectures for delivering data
- User interface design within Flux Studio, for easy placement of geospatially located objects

Media Machines

## **K. X3D EARTH WEB VIEWING AND AUTHORING REQUIREMENTS**

by Toni Parisi, Media Machines, Inc.

### **Abstract**

This document describes Media Machines' involvement in the X3D Earth initiative being led the Naval Postgraduate School and the Web3D Consortium in partnership with Web3D vendors and affiliate organizations. Our specific areas of focus in this research are the deployment of X3D Earth content within web browsers, developing high performance and lightweight implementations for rendering and interaction, and providing affordable authoring solutions for integrating 3D models and geospatial data into real-time scenes.

### **Introduction**

The Naval Postgraduate School and the Web3D Consortium are spearheading the development of X3D Earth, a standards based geospatial visualization system usable by governments, industry, scientists, academia and the general public. X3D mappings of world terrain, cartography and imagery will be made available for use in any scene, making it easy to geospatially reference and share X3D models.

X3D Earth will employ open standards, web architectures, XML languages and open protocols throughout, and emphasize best practices. Vendors with closed- and opensource code bases will be able to participate. The Web3D Consortium is forming an X3D Earth working group to guide and manage the various activities related to the development of standards and best practices for the project.

Media Machines is participating in X3D Earth at several levels: as a strategic partner interested in advancing the project's long-term goals; as a developer creating low-cost, accessible solutions for the web; and as a long-time contributor to the architecture and development of the X3D standard. This paper outlines Media Machines' participation in the project, including our business goals, product development plans, technical requirements, and the challenges that lay ahead.

### **Strategic Goals**

Media Machines' mission is to establish our Flux™ technology as a premier platform for 3D web content and experiences. The company believes that geospatial visualization can greatly enhance those experiences, and that geospatial applications delivered on the web represent a significant commercial opportunity. The key to unleashing that opportunity is an open, web-based platform that allows geospatial data to be integrated with other web and 3D data into a seamless experience.

X3D Earth promises to develop an open, standards-based infrastructure for earth visualization. Media Machines is primarily interested in participating in the initiative to achieve the following strategic goals:

- **Web-based Earth viewing for all**, via a simple plug-in to web browsers. Earth viewing should not be trapped inside a “walled garden” or point product solution but should be deployable within a web browser;
- **AJAX and “mashup” support**. The geospatial data delivered within a web browser must be programmable via web scripting languages, and able to be integrated visually with other web page elements and web-based information services;
- **Open, web-based data format**. The geospatial data itself should be based on open standard formats, deliverable over standard HTTP and accessible via AJAX and other request methods (such as X3D SAI createXXX calls).

### **Requirements for X3D Earth Technical Architecture and Shared Implementations**

For this project, Media Machines will focus on requirements for web-based presentation and data access. These include:

- Full support for the existing X3D Geospatial rendering component, as well as extensions to that component deemed necessary to achieve quality rendering at the level of Google Earth or NASA World Wind;
- Improvements to the viewing, navigation and interaction models within X3D browsers;
- Specification and development of streaming delivery, programmatic access and other dynamic aspects of the architecture, with a particular focus on Ajax and lightweight Web deployment;
- Full support for the proposed X3D Earth (“X3DE”) component of the X3D specification, and demonstrated interoperability with other X3DE-conformant browsers

### **Media Machines Assets Available to Contribute to This Effort**

Media Machines is a leading developer of open source, web-based solutions based on X3D. Our specific business focus is on software for developing consumer-grade content and applications in entertainment, e-commerce and social networking. We have several platform technologies and products that we can bring to bear in this project:

- **Flux Player** – an open source, X3D-conforming lightweight web plugin for Firefox and Internet Explorer;

- **Flux Studio** – an easy to use authoring and publishing package for creating X3D content, free for personal/academic use and affordable for professionals;
- **Flux Widgets** – an online service that allows X3D content creators to upload and share 3D models, scenes and applications, hosted at [www.mediamachines.com](http://www.mediamachines.com);
- **Ajax3D** – An open initiative, led by Media Machines, to develop Ajax-based libraries, development frameworks and best practices for web-based 3D application deployment – hosted at [www.ajax3d.org](http://www.ajax3d.org).

### **Access and Intellectual Property Rights (IPR) Restrictions**

Media Machines does not have any intellectual property restrictions that will impact this project.

### **Team; Related Work**

Machines has been involved in several projects, past and ongoing, that are related to the X3D Earth initiative:

*ARIVA Project.* Media Machines is a subcontractor on the NPS ARIVA (Advanced Research in Interactive Visualization for Analysis) X3D Earth project. Our specific development tasks for that project are as follows:

- Assist preparing X3DE Component documentation for Web3D and ISO approval; specifically review for feasibility rendering on Windows/DirectX.
- Add proven geospatial extensions and X3D-Earth support to Flux web browser plug-in for Windows clients, Internet Explorer and Firefox browsers
- Extend FluxStudio authoring tool to support proven geospatial extensions and X3D-Earth
- Develop sample lightweight X3DE Global Viewer capable of running in a web page, based on AJAX architecture ("AJAX3D")

*City of St. Paul Mapping Prototype.* Media Machines has been contracted by the City of St. Paul, MN, to develop an X3D-based web prototype to visualize the city's terrain data with layers that include satellite imagery, streets and other infrastructure.

*Team.* Media Machines' technical team includes leading X3D specification team members and web pioneers: CEO Tony Parisi, Engineering Vice President Keith Victor, CTO Jay Weber, and senior engineer Dave Arendash, all of whom have made significant contributions to X3D and other web standards and protocols. Our team is also leading the charge in open web3D development with the Ajax3D initiative and the innovative information services hosted at [www.mediamachines.com](http://www.mediamachines.com)

### **Unresolved Technical Challenges**

Media Machines has identified several technical challenges for this project, as follows:

- Intuitive earth-based navigation interface
- Multi-resolution terrain rendering
- Data layering – optimizing performance and rendering
- Client-server networking – architectures for delivering data
- User interface design within Flux Studio, for easy placement of geospatially located objects



## L. X3D EARTH REQUIREMENTS NOTES

by Nick Polys, Chris North and Doug Bowman, [Virginia Tech](#)

### X3D Earth Requirements Notes

Nicholas Polys ([npolys@vt.edu](mailto:npolys@vt.edu))  
Research Computing

Chris North ([north@vt.edu](mailto:north@vt.edu))  
Department of Computer Science, Center for Human Computer Interaction

Doug Bowman ([bowman@vt.edu](mailto:b Bowman@vt.edu))  
Department of Computer Science, Center for Human Computer Interaction

Virginia Tech  
Nov. 3, 2006

### Background

Faculty at Virginia Tech Department of Computer Science and the Center for Human Computer Interaction have been studying the usability and productivity aspects of large high-resolution displays and immersive technology. Through empirical methods, we are identifying features and design aspects of these visualization systems and which positively and negatively impact human performance. We have addressed a number of relevant applications including Geospatial Analysis and Situational Awareness.

Through our research programs, we have assessed the impact of large high-resolution displays on analysts – what we call the ‘Analytic Force Multiplier’

- 2-10x faster task performance
- Analyze 22x more data, only 3x more time, while maintaining accuracy
- Curved displays speed some tasks by 30%
  - Reduce frustration by 50%
  - Reduce virtual navigation actions by 75%
  - Increase physical navigation 300%
- Greater situational awareness
- Easier interaction
- Short initial learning time
- Visualization design guidance

We have also noted productivity and insight benefits with our tiled High-Res displays of conventional monitor configurations. When configured as a flat wall, users show reduced frustration and more global insights. When the displays are curved, users show a 30% performance gain, reduced frustration, Less Fatigue (turning instead of walking), and more detailed insights.

## Proposed Requirements for X3D Earth

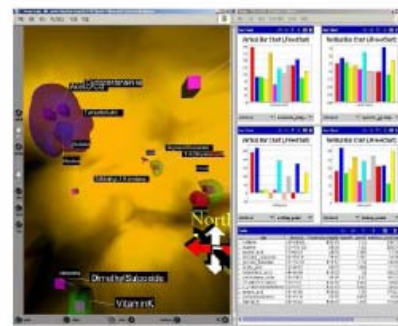
1. High-resolution display workspaces for analysts enable analysts to accomplish more tasks with more data faster.

**REQUIREMENT:** Ability to output display on multiple monitors with hardware acceleration



2. Federated applications that support multiple views and event sharing (e.g. load, select events for brushing and linking) are beneficial for visualization tasks.

**REQUIREMENT:** API to expose scenegraph nodes to external applications. Where Object IDs are consistent, the X3D SAI may be sufficient when used in combination with spatial statistics and reasoning tools.



3. Immersive and Gigapixel display require interactions that are not constrained to the desktop / WIMP paradigm. Our research in 3D user interfaces has demonstrated that principled design can make large complex spaces more intuitive to navigate, select, and manipulate.

**REQUIREMENT:** Ability to compose engine interfaces through multiple input devices (e.g. head and device tracking data for gestural and 3D user interfaces, touch screens).



### Relevant Resources:

VT Laboratory for Information Visualization and Evaluation : <http://infovis.cs.vt.edu/>


VT 3D Interaction Group : <http://research.cs.vt.edu/3di/>

### Toolkits

- DMX - <http://dmx.sourceforge.net/>
- Chromium - <http://chromium.sourceforge.net/>
- SAGE - <http://www.evl.uic.edu/cavern/sage/index.php>
- ParaView - <http://www.paraview.org/HTML/Index.html>
- DIVERSE - <http://diverse-vr.org/>

## M. 3D IN THE OPEN GEOSPATIAL CONSORTIUM (OGC)

by Raj Singh, [OGC](http://www.opengeospatial.org)



OGC  
Open Geospatial Consortium

### 3D in the OGC

X3D-Earth Requirements Workshop  
MOVES Institute, Naval Postgraduate School  
Raj Singh, PhD  
November 14, 2006

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### What is the OGC?

- The Open Geospatial Consortium, Inc. (OGC) is a non-profit, international voluntary consensus standards organization that is leading the development of standards for geospatial and location based services.
- The OGC facilitates a consensus process in which government, private industry, NGOs, and academia collaborate to create open and extensible software application programming interfaces for geospatial and other mainstream information technologies

• [www.opengeospatial.org](http://www.opengeospatial.org)

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### 3D Initiatives

- GML/CityGML
- Web Terrain Service
- CAD-GIS-BIM
- Google/Sketchup integration

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### Sponsors & Objectives

General Services Administration:

- Incorporate NBIMs Space Assessment capabilities in an web services architecture

National Geospatial Intelligence Agency

- Develop three dimensional visualization aspects of OGC Interoperability Program


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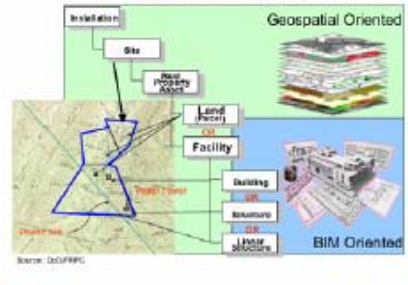
### Demo Scenario: Field Hospital at Newark Airport



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### Seamless semantics and spatial information for CAD/GIS/BIM



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## BIM In Context for Project Development

AEC Projects will benefit by integrating BIM in geospatial context throughout **project** lifecycle:

- Initial ground condition from WMS/WCS will aid in initial site planning
- Existing and surrounding site buildings may be delivered from WFS as CityGML
- Detailed engineering connections and conflicts may be understood and modeled by integration of BIMs of neighboring sites



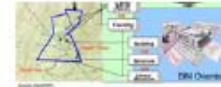
OGC

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## BIM In Context: For Modeling Cities

Broad-scale assessment will be facilitated by integration of information aggregated from **multiple** BIMs:

- Space Planning
- Build-Out Analysis
- Emergency Planning/Management
- Detailed, 4-D Virtual City Applications
- We Expect this aggregation of general information from BIM to be enabled through Web Feature Services and CityGML



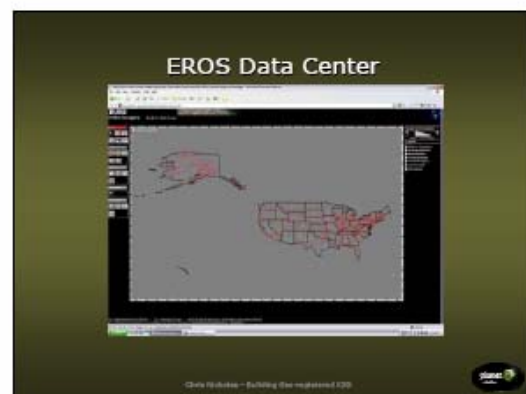
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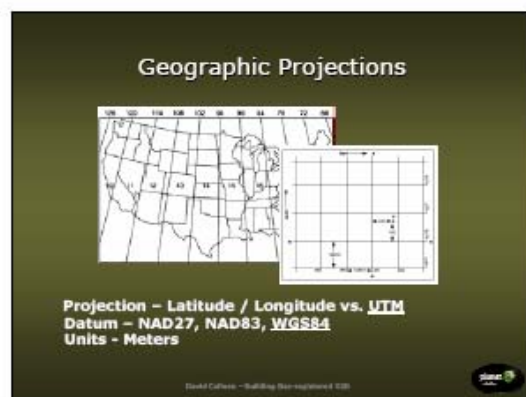
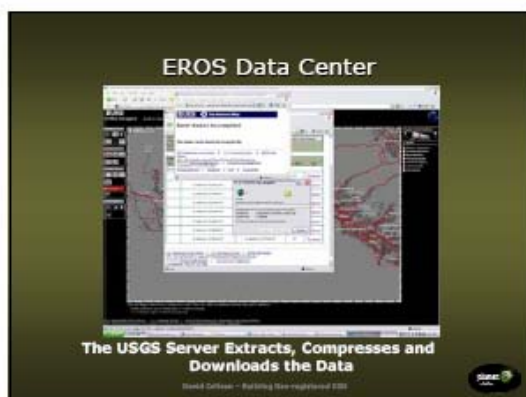
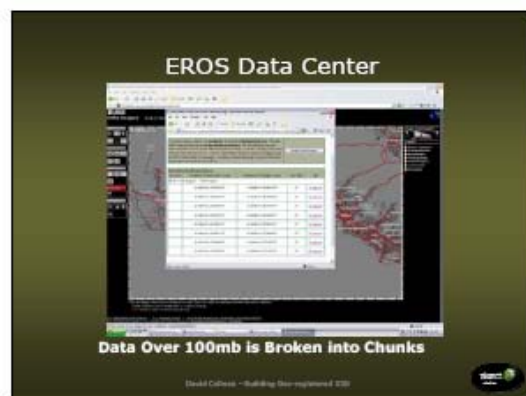
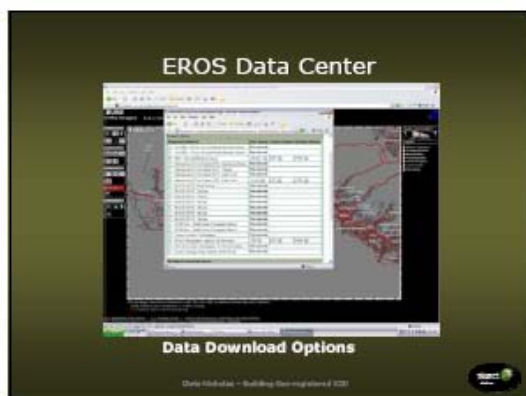
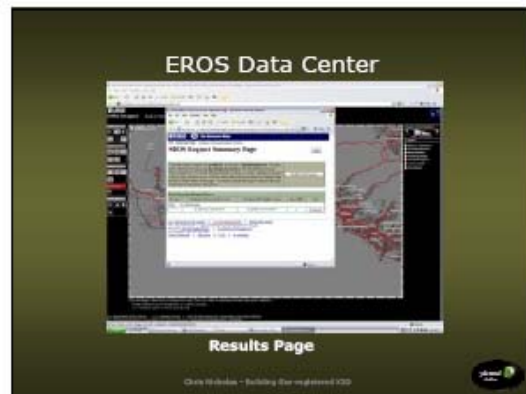
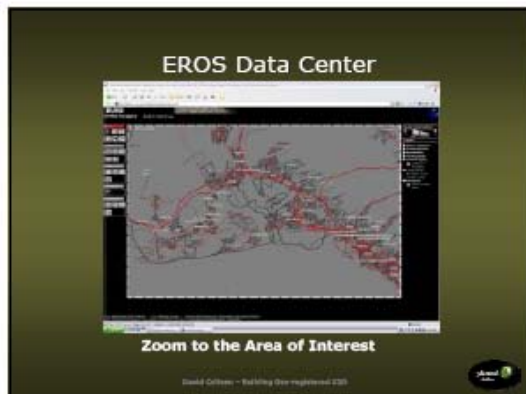
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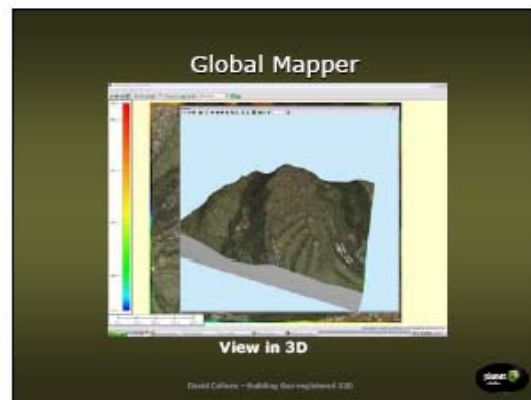
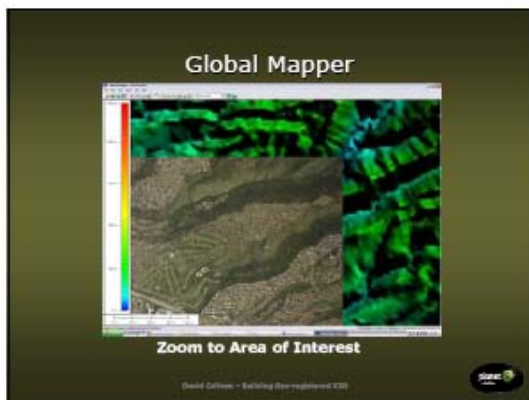
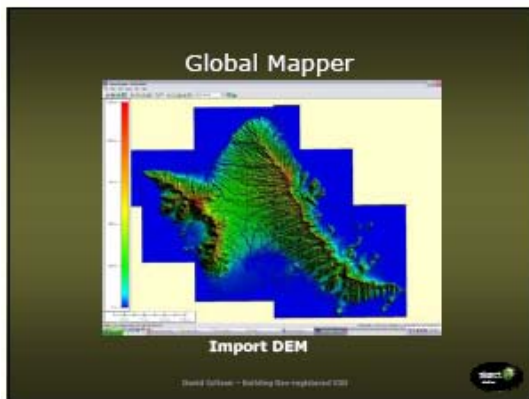


## N. BUILD GEO-REGISTERED X3D: TERRAIN AND CITY MODELS... ACCURATELY PLACED

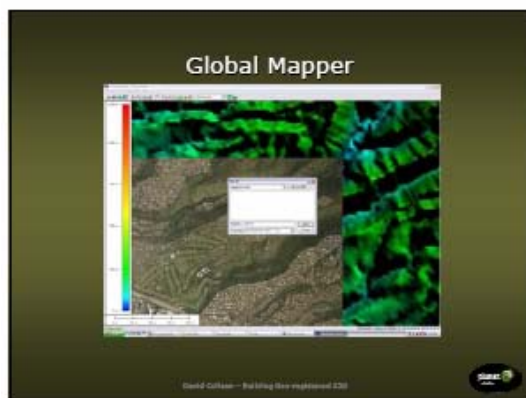
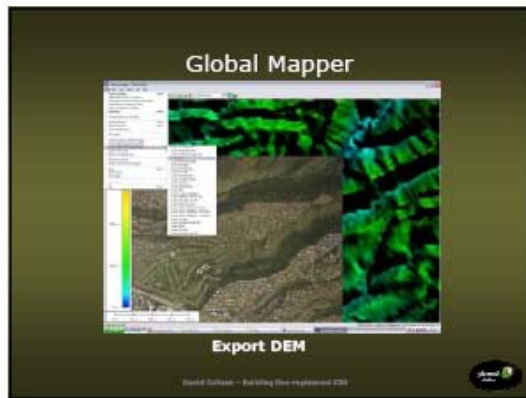
by Chris Nicholas, [Planet 9 Studios](http://www.planet9.com)

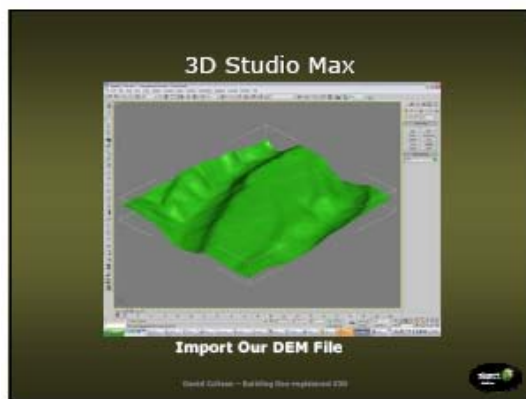






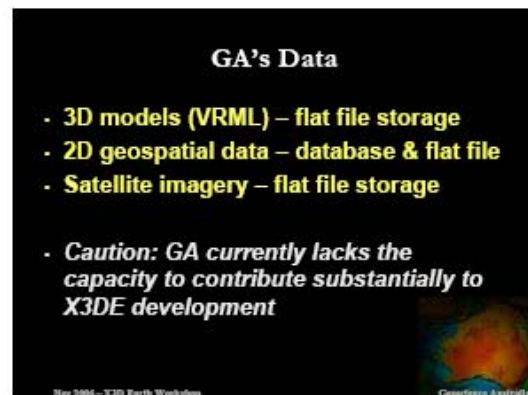
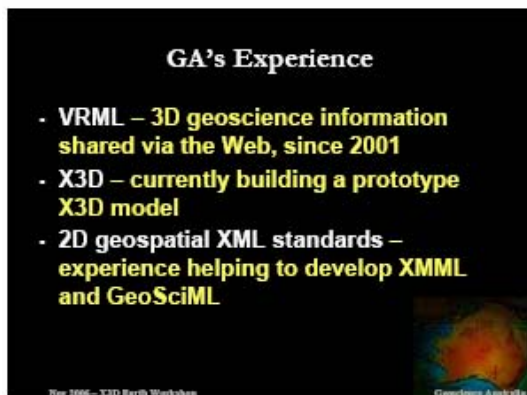
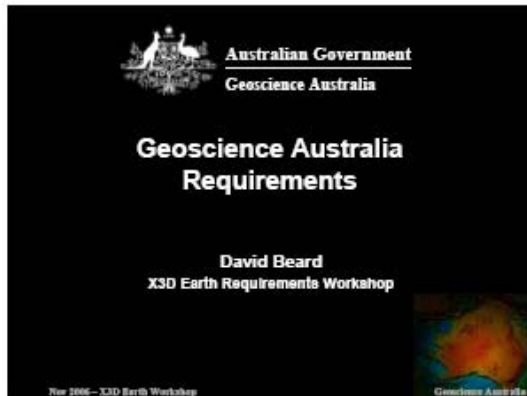






## O. GEOSCIENCE AUSTRALIA REQUIREMENTS

by David Beard, [Geoscience Australia](http://www.geoscienceaustralia.gov.au)



X3DE Technical Requirement	Current Status
Open and standard 3D file format	X3D meets this need.
Streaming of data	Not yet available in X3D.
Binary encoding	X3D binary encoding should meet this need.
On-the-fly reprojection	Not yet available in X3D and X3D browsers.
Querying of 3D data for attributes	Currently available in X3D.
Extensible Stylesheet Language Transformations (XSLT)	Do these XSLTs need to be written?

X3DE Technical Requirement	Current Status
Open and standard protocols to request X3D data from Web servers	The OGC published a Web 3D Service discussion paper in 2005.
Send requests to Web servers from within X3D using open and standard protocols (such as WMS, WFS and WCS) and to convert the returned data to X3D.	Current support for WMS via http requests. Interchange parsers needed to support data returned from WFS and WCS requests
Support from multiple X3D browsers.	How quickly will the browsers pick-up the above requirements?
Easy X3DE interface authoring.	Currently available.
Digital libraries of X3D Earth datasets, with comprehensive metadata.	Is the X3D metadata sufficient? Who will collate and manage digital libraries?

### X3DE Challenges

- X3D browser support
- Larger scale commercial support
- Native Web browser support
- Interoperability standards for 3D
- Global  $\leftrightarrow$  non-global reprojection

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Geoscience Australia

### X3DE Challenges (2)

- Operating in the same space as Google Earth
- Who's the target audience?
- Marketing to data providers
- Developing & managing libraries of X3DE datasets

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### Strategic partnerships

- OGC
- X3D browser companies
- Database and geospatial software companies
- Web browser companies
- Data providers

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### Next Steps

- Discussions with OGC
- X3D browser support for X3DE
- Discussions with data suppliers
- Making the required X3D amendments

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### Key Points

- Handle geospatial data well
- 3D interoperability standards
- Stream data well
- Who's the target audience?
- X3DE dataset libraries

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## **P. X3D EARTH WHITE PAPER**

by Michael Remsey, [Mortensen](#)

### **X3D Earth White Paper for the Web3D Consortium**

November 6<sup>th</sup> 2006

#### **Abstract:**

The MA Mortenson Company is an industry leader in the development and utilization of Building Information Modeling (BIM) within the AEC fields. As such we are continually pursuing new technology and technology advancements for use in our day to day work. Our integrated design advancement team spearheads these pursuits working with project teams, consultants and sub consultants to investigate any and all relevant avenues for improved work flow and process.

In its pursuit of both accurate BIM and business development goals Mortenson foresees a need for a highly intuitive and highly detailed X3D model of the Earth. This model would be most helpful if it met a certain list of criteria and needs. This list is compiled from the suggestions of a group of at least 30 architects, engineers, and construction professionals at Mortenson and represents current and future needs of the AEC industry at large.

It is the hope of Mortenson that all suggestions be considered and discussed and that the list of requirements for an X3D Earth will assist the web consortium in producing a valuable tool for the industry.

#### **List**

The following is a list of requests features to incorporate into an X3D earth compiled from the suggestions of the AEC industry at large. These request stem from day to day work within the industry and subsequent needs. A manageable X3D Earth would be an invaluable tool booth in design and construction as well as coordination and business development. While there are solutions currently available most are geared toward the general public. The practical capabilities of these existing solutions do not fully satisfy the needs of the AEC industry.

The list should be read in descending order of importance per section. It is difficult to anticipate the myriad ways an X3D Earth could be used within the AEC industry. Projects vary so widely that each end user may have specials needs unique to their project. The order of importance was determined by number of requests for a certain function. While there were some unique requests most respondents agreed with their peers and requested similar functions.

#### **Physically functionality**

- Create a user friendly interface that allows for the easy importation and manipulation of 3D models. Support as many file formats as possible or provide conversion abilities.

- Support different navigation modes (Fly Vs. 1<sup>st</sup> person interface)

- User defined layers system to allow for different display and navigation settings in one model.
  - Ability to measure and query geometries.
  - The ability to add view independent text and tags
  - The ability to add hyperlinks to geometry and text and tags
- 
- Be able to change and manipulate the X3D Earth to support different needs.
    - Be able to move below ground
    - Hold back geometry in order to place imported models (i.e.) building foundations)
    - Be able to move underwater.
    - Ability to hide unwanted areas
    - Allow for transparency

### **Import and Export**

- Support importing and exporting of geometries and secondary data.
  - Accommodate as many file formats as possible both for import and export
  - Parcel and Zoning Information: zoning, land use, special districts, utilities, Lot and Block info...
  - Economic Development GIS Property Locator and Reports
  - Downloadable GIS information
  - Be able to create, and save an association between a coordinate system and a cad coordinate system so that geometries only have to be positioned on the earth model once.
  - Included a references to coordinate systems other than latitude and longitude. For example locate objects on the earth according to state plane coordinate system.
  - Provide a user friendly and flexible interface to locate objects on the earth accurately. For example be able to tell the program the Northing and Easting and State plane of the origin of your CAD file and have it position the building on the Earth.
  - Be able to import/export Google earth KML files where there are similarities between the programs.
  - Ability to export terrain (in several 3D and 2D formats)
  - General export abilities including geometry.

### **Display and View**

- Create robust display controls
  - Flexible view control that can be used to create and store viewpoints

- Ability to create viewpoints relative to imported geometry (i.e. standing at the base of the geometry looking up.
- Support for animation
- Support materials and mapping either 3<sup>rd</sup> party or integral.
- Support shadows, alpha channels
- Real world Lighting information support (geographic location etc)
- provide rendering or static image creation functions (Screen capture, print, render)

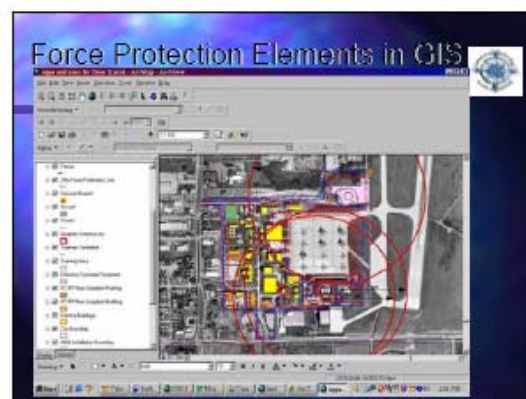
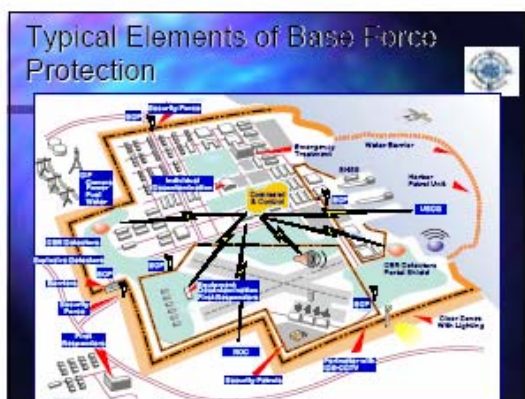
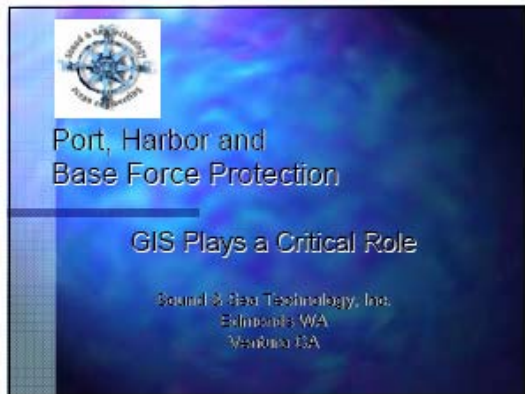
### **Technical Considerations**

- Secondary Hardware and software support
  - Viewing / reading standalone software (no edit capabilities)
  - Stereo Viewing support
  - Spaceball or other physical user interface support.

thank you for taking the time to review this list and hope that the Web Consortium and X3D Earth development group can and will implement many, if not all, of the ideas and requests contained in the above list. An X3D Earth will be an invaluable tool for the AEC industry and we applaud and support your effort.

## Q. PORT, HARBOR AND BASE FORCE PROTECTION: GIS PLAYS A CRITICAL ROLE

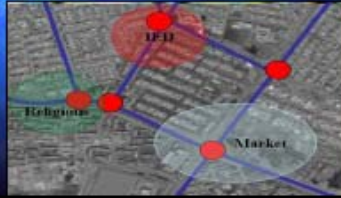
by Dallas Meggitt, [S&ST](#)





## Deter

- Identify entry/egress paths
- Vulnerabilities – assess effectiveness of mitigation measures



## Deter (VBIED Example)



VBIED access routes identified on base map allow risk identifying Traffic Control Points to limit target access

Also allows concentration of defense assets at points and most critical locations of resources

Increased resources at most likely controlled entry points acts as deterrent



## Detect

- GIS provides basis for merging/fusion of multi-sensor data overlaid on base map in real time
  - Terrestrial (visual, IR, radar, thermal imager)
  - Maritime surface and subsurface
- GIS provides the "common" in "Common Operating Picture"

## Underwater Intrusion Detection

- Passive acoustic underwater intrusion detection system for detection of divers, surface craft, U/W vehicles
- Demonstration system installed at Port Hueneme CA 2004, upgraded 2006
- Multi-sensor data integrated into GIS for target location and tracking



## Modeling & Simulation (M&S) for Anti-Terrorism

- GIS provides base map for implementation of ATRP systems
- Use of standard M&S tools to model and assess performance of perimeter defense systems



High-resolution 3-D rendering image of Bremerton allows assessment of effectiveness of ATRP systems with M&S tools

## Warn



Overlay of risks on base map allows efficient identification of population at risk, warning, dispatch, evacuation,

## Respond



- Response is centrally dispatched
- Requires common geographic reference for dispatcher, responder
  - More attributes, the better
  - Examples: building drawings, electrical and other utilities, underground features
  - Hazards locations

## Consequence Management



- National Incident Management System (all hazards)
- Consequence Management Interactive Mapping Service
- CM/EM tools are GIS-based (currently ESRI)

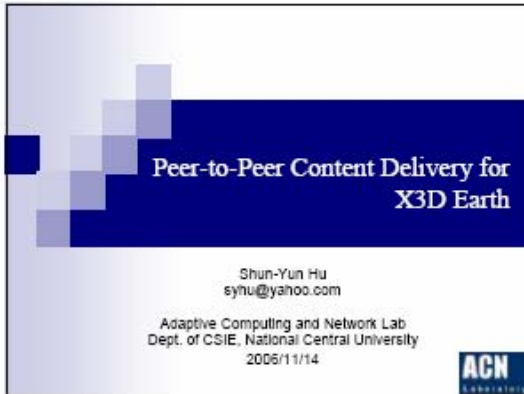
## Implications for X3D World Requirements



- Target ATRP users:
  - Base, port, facility planners
  - System/equipment specifiers/purchasers
  - Force protection officers
  - Security planners/staff
- X3D World requirements
  - Complete compatibility with ESRI files
  - BASE OR USE!
  - Ease of changes in GIS (add or move sensors, change object points for red or blue, etc.)

## R. PEER-TO-PEER CONTENT DELIVERY FOR X3D EARTH

by Shun-Yun Hu, [National Central University Taiwan](http://www.nctu.edu.tw/~syhu/)

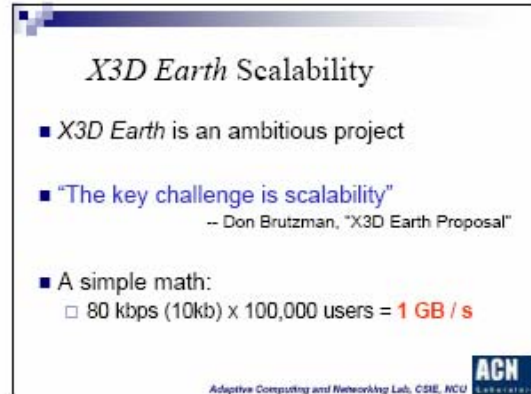


Peer-to-Peer Content Delivery for  
X3D Earth

Shun-Yun Hu  
syhu@yahoo.com

Adaptive Computing and Network Lab  
Dept. of CSIE, National Central University  
2005/11/14

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Laboratory

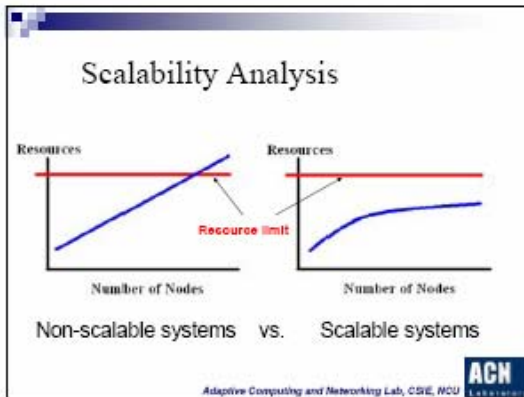


*X3D Earth* Scalability

- *X3D Earth* is an ambitious project
- "The key challenge is scalability"  
-- Don Brutzman, "X3D Earth Proposal"
- A simple math:
  - 80 kbps (10kb) x 100,000 users = **1 GB / s**

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Scalability Analysis

Resources

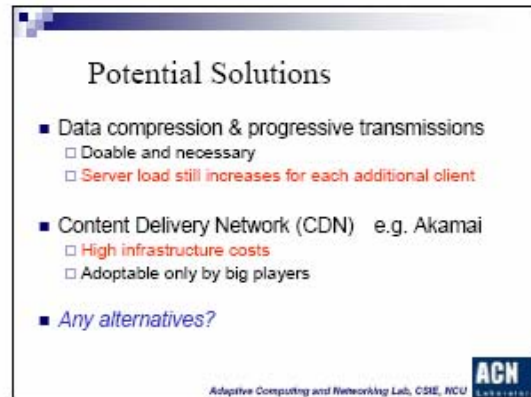
Number of Nodes

Resource limit

Non-scalable systems vs. Scalable systems

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Potential Solutions

- Data compression & progressive transmissions
  - Doable and necessary
  - Server load still increases for each additional client
- Content Delivery Network (CDN) e.g. Akamai
  - High infrastructure costs
  - Adoptable only by big players
- Any alternatives?

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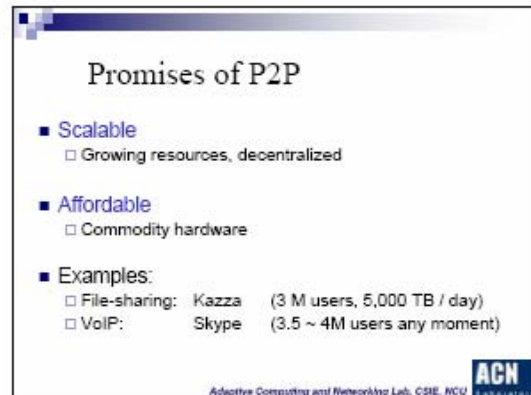
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overlapped visibility = shared contents

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Promises of P2P

- Scalable
  - Growing resources, decentralized
- Affordable
  - Commodity hardware
- Examples:
  - File-sharing: Kazza (3 M users, 5,000 TB / day)
  - VoIP: Skype (3.5 ~ 4M users any moment)

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## Challenges of P2P 3D streaming

- Limited client-side bandwidth
  - Typical end-system is asymmetric (small upload)
  - BitTorrent achieves 30KB/s ~ 50KB/s avg. download
- NAT-traversal
  - NAT-boxes are very common
  - Practical solutions exist
- Peer and piece selection
  - Find the right peers to connect, and pieces to obtain
  - Research still required for efficient solutions

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## Our Capabilities

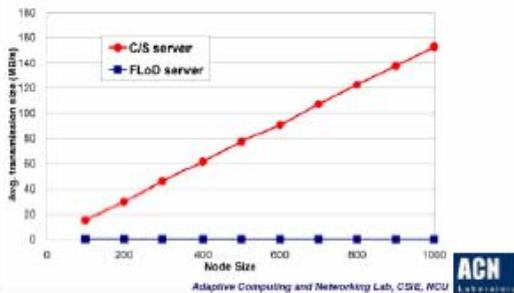
- P2P-based virtual environments research
  - Voronoi-based Overlay Network (VON)
  - IEEE Network publication (July 08)
- P2P-based 3D streaming research
  - Flowing Level-of-Details (FLoD)
  - Initial results soon to release as technical report



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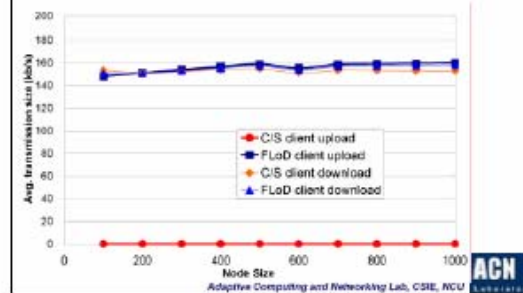
## Simulations (server bandwidth use)



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## Simulations (client bandwidth use)



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## Conclusion

- Scalability is a core X3D Earth challenge
- P2P is the most sensible delivery choice
- Related issues are practically addressable

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## Final remarks

People in this business tend to fixate on the technology side of things. The technology side is actually really easy. You can predict what's going to work technologically and what's not going to work. The thing that's hard — and the thing that most people don't want to admit is the hard part — is the social experiment. What is it that people want?

— James Gosling

- Make X3D Earth the social experiment platform for virtual worlds / environments
- Multi-user is easily extensible with P2P

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## References

### ■ Kazza

- Jian Liang et al. "Pollution In P2P File Sharing Systems," Proc. INFOCOM, 2005

### ■ Skype

- Kuan-Ta Chen et al. "Quantifying Skype User Satisfaction," Proc. SIGCOMM 2005

### ■ Voronoi-based Overlay Network

- Shun-Yun Hu et al. "VON- a scalable peer-to-peer network for virtual environments," IEEE Network, 2005

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**ACN**  
Lecture 6

## **S. X3D EARTH REQUIREMENT RECOMMENDATION: PEER-TO-PEER (P2P) STREAMING CONTENT DELIVERY**

by Shun-Yun Hu and Jehn-Ruey Jiang, National Central University Taiwan

### **Abstract**

Web3D Consortium's new initiative *X3D Earth* will attempt to create a browsable environment of planet Earth in full 3D, providing access of a vast amount of 3D contents to a wide range of users that include the general public. Scalability of the system architecture and delivery mechanism thus is recognized as an important goal and requirement for *X3D Earth*. However, today's predominant client-server based content delivery mechanism has shown inherent scalability limits and possesses a single point of failure; while server-cluster based solutions such as content delivery networks (CDNs) may be expensive in both cost and maintenance. This paper recommends the use of peer-to-peer (P2P) network as the main delivery mechanism, in order to solve the scalability problem in a cost-effective manner.

### **What is P2P?**

Peer-to-Peer (P2P) is a method to network large number of commodity computing resources for a collective goal. It has gained widespread attention and popularity in recent years via file-sharing software such as Napster, Gnutella, Kazza, eDonkey, as well as voice-over-IP (VoIP) software such as Skype [1]. P2P distinguishes itself from the more traditional client-server paradigm by providing high scalability without incurring the costs of dedicated servers that provide equivalent services. This is achieved through utilizing resources (CPU, bandwidth, and storage) provided by the users of the network, so the amount of total usable resources actually increases with the number of concurrent user, as opposed of being consumed only in client-server architectures.

### **Why P2P?**

The major benefits of a P2P architecture are scalability and affordability. A system reaches its scalability limit when its resources are depleted. For most network applications this limiting resource is the bandwidth at the server. For example, if a web server has a T1 connection (1.544Mbps) to the outside and each user consumes 10 kbps (a little more than 1KB per second), it will have a theoretical limit of about 150 concurrent users ( $1544 / 10 = 154$ ). Although the amount of server-side resources may increase by provisioning more servers and server-side bandwidth (e.g. content delivery networks, or CDNs, such as Akamai [2]), this will introduce the issues of design complexity, over-provisioning, load-balancing, and maintenance. On the other hand, P2P systems take advantage of the CPU and bandwidth resources of user computers, so the amount of total usable resources actually increase with user size. If designed well, P2P systems can provide superb scalability with only light server-side provisioning.

As the required amount of server resources is limited, P2P systems can be easier to maintain and cheaper to host than client-server architectures that provide equivalent

services. This can be seen from the example of BitTorrent [3], a popular P2P design for delivering large files. Measurement studies have observed an average download rate between 240 kbps and 500 kbps (30 ~ 60KB/s) [4, 5], while many content providers have used BitTorrent to provide large-scale distributions of their contents without incurring expensive bandwidth bills (for example, one student distributed a total of 750 GB of contents by paying only USD\$4 for the bandwidth [6]). If the costs to host an *X3D Earth* server is sufficiently low, one important implication is that interested parties may develop and host extensions using other datasets by using *X3D Earth*'s open source codebase.

For *X3D Earth*, scalability in terms of the number of concurrent users has been recognized as the key challenge. Scalability will be a concern given the potential popularity and wide interests from its diverse user groups, and the issue is compounded by the fact that real-time 3D data transmission can be both CPU and bandwidth intensive (i.e. visibility determination requires CPU power, while the delivery of 3D contents requires bandwidth). Without a scalable design built into its delivery mechanism, the popularity and adoption of *X3D Earth* will likely be hindered.

### **Challenges**

Given P2P's benefits, it may be desirable that the basic content delivery mechanism of *X3D Earth* is based on a P2P architecture. However, there are at least two technical challenges involved:

#### **1. Compressed and progressive encoding of 3D contents**

In order for users of *X3D Earth* to access the vast amount of 3D contents, sending the contents progressively and compactly (i.e. via streaming delivery) is essential. This will allow clients to render the screen as soon as a few data pieces are obtained, and the view can then be progressively refined as more data pieces arrive.

#### **2. Adaptation of P2P streaming for 3D contents**

Although solutions for P2P-based file delivery and media streaming exist [7, 8], unlike static file or media contents, 3D streaming requires the delivery of many 3D objects based on visibility calculations, existing approaches therefore may not work out of the box [9]. For example, although BitTorrent is efficient at delivering large non-sequential data files, it was not designed for streaming. Modifications or new schemes may thus need to be devised.

### **What we can contribute (our capabilities)**

Our lab has been investigating the usage of P2P architecture to support multi-user virtual environments, and recently on the streaming delivery of 3D contents. Our P2P work has appeared in *IEEE Network* [10], one of the leading academic journals in computer networking, and our P2Pbased 3D streaming proposal was presented during *Web3D 2006* [9]. Simulation results showing significant bandwidth saving by P2P delivery is also described in a recent technical report [11]. Starting from August 2006, we have a three-year research project funded by the National Science Council of Taiwan to conduct P2P-based networked virtual environment research, where the first research

topic is on P2P-based 3D streaming [12]. We are thus able to contribute research concepts and prototype implementation of P2P-based streaming solutions for 3D contents that are usable by the *X3D Earth* project.

### **What do we need?**

As the main research direction of our lab is on distributed system, P2P networking and content delivery, but not computer graphics, we will likely need the inputs and collaborations from graphics experts in the first challenge of P2P-based 3D streaming -- the compressed and progressive encoding of 3D contents usable for *X3D Earth*. We therefore welcome and seek collaborations with academic or industrial partners on the graphics aspect of this challenging task.

### **Conclusion**

*X3D Earth* is an ambitious yet worthwhile project where the results may benefit diverse groups of users. The system needs to be both scalable, in order to service large number of concurrent users, yet at the same time, be affordable so that independent services and additional sites may be created by interested parties. Peer-to-peer architecture thus is a more sensible choice over the traditional client-server based delivery mechanisms. We recommend that P2P delivery be included as part of the requirements of *X3D Earth*, and our lab is willing to provide the necessary research and implementation support. However, we do need the inputs and collaborations from graphics experts, in solving some of the unique issues of compressed and progressive encoding of 3D contents, and devising suitable P2P-based streaming mechanisms for 3D contents.

### **References**

- [1] Wikipedia, definition of Peer-to-peer. <http://en.wikipedia.org/wiki/Peer-to-peer>
- [2] Akamai Technologies, Inc., <http://en.wikipedia.org/wiki/Akamai>
- [3] B. Cohen, "Incentives build robustness in bittorrent," in Proc. Wksp. on Economics of Peer-to-Peer Systems, 2003.
- [4] J.A. Pouwelse, P. Garbacki, D.H.J. Epema, and H.J. Sips, "The Bittorrent P2P File-Sharing System: Measurements and Analysis," in Proc. 4th Intl. Wksp. on Peer-to-Peer Systems (IPTPS'05).
- [5] M. Izal, G. Urvoy-Keller, E. Biersack, P. Felber, A. Al Hamra, and L. Garc es-Erice, "Dissecting BitTorrent: Five Months in a Torrent's Lifetime", in Proc. Passive and Active Measurements 2004.
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- [10] Shun-Yun Hu, Jui-Fa Chen and Tsu-Han Chen, "VON: A scalable peer-to-peer network for virtual environments," IEEE Network, vol. 20 no. 4, Jul./Aug. 2006
- [11] Shun-Yun Hu, Shao-Chen Chang, Wei-Lun Sung, and Jehn-Ruey Jiang, "A Case for Peer-to- Peer 3D Streaming," ASCEND Technical Report (ASCEND-TR-002-2006A). <http://ascend.sourceforge.net/docs/pub/ASCEND-TR-002-2006A.pdf>
- [12] ASCEND project, <http://ascend.sourceforge.net>

## T. OPEN STANDARDS FOR EXCHANGING COMMAND AND CONTROL AND GEOSPATIAL INFORMATION

by Hike Heib and Dr. Mark Pullen, [George Mason University](#)



## **U. OPEN STANDARDS FOR EXCHANGING COMMAND AND CONTROL AND GEOSPATIAL INFORMATION**

by Dr. Michael R. Heib, Dr. J. Mark Pullen, Curt Blais and Dr. Don Brutzman

Open Standards are critical for obtaining actionable geo-information within a Command and Control (C2) context. Current Command and Control systems utilize a wide variety of 2D and 3D visualization technologies. However, most of the map displays developed in the last 10 years are raster based and do not employ a Geospatial Information System (GIS). However, the commercial world employs GIS widely for visualizing and processing geospatial information.

Terrain and weather effects represent a fundamental, enabling piece of battlefield information supporting situation awareness and the decision-making processes for C2). These effects can both enhance or constrain force tactics and behaviors, platform performance (ground and air), system performance (e.g. sensors) and the soldier.

Battlefield Management Language (BML) is being developed as a open standard for specifying military missions. Within NATO the task group MSG-048 “Coalition BML” is defining a BML using the Command and Control Information Exchange Data Model (C2IEDM) as a lexicon. The integration of actionable terrain and weather information within a Coalition C2 process can best be accomplished by developing a common “abstract” representation of geo-environmental objects – a geoBML. These common spatial objects are defined as those required in a specific mission context (e.g., an “assembly area” to stage equipment). Also required is the explicit set of tactical relationships between the expanded set of geo-environmental objects and military missions.

Currently, terrain data and C2 data are stovepiped in C2 systems and applications. C2 information is overlaid on a map in a hap-hazard fashion. geoBML is a solution to this problem and has the potential to be a well specified interface to enable modern GIS systems to geolocate C2 information for modern C2 applications. The current geospatial tool for US Defense applications is C/JMTK (the Commercial Joint Mapping Toolkit), a developers package that provides robust GIS functionality. However, C2 systems would benefit from a well codified interface between C/JMTK and the C2IEDM. Similarly, other GIS systems that provide additional functionality to C/JMTK require such an open standard to provide advanced visualization, terrain reasoning, etc.

Open standards for GIS are an enabler for C4I system development and deployment. Having both open source 3D earth and commercial products such as C/JMTK conform to the same standards is necessary in the future.

## V. X3D EARTH 2006: REQUIREMENTS FOR EXPLOITING SIMULATION SPACE PROPERTIES TO IMPROVE SCALABILITY AND FIDELITY

by Chris Thorne, [Ping Interactive](#)



### X3D Earth 2006

#### Large scale simulation

- Increasingly popular: Virtual Earths, MMOGs, Single User games, Scientific and Industry
- Some problems endemic to large scale simulation: jittery motion, inaccurate interaction & placement, rendering artifacts
- Generically termed *spatial jitter*

### X3D Earth 2006

#### Spatial Jitter results from:

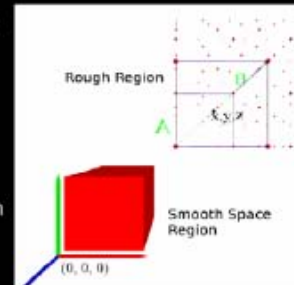
- Mapping real world navigation rules onto virtual world
- Incomplete understanding of constraints/properties of floating point simulation space and the underlying simulation hardware/software

### X3D Earth

(x,y,z) is quantised in virtual world

Spatial jitter more noticeable in rough region – away from origin

Imagine if entire simulation could be in the smooth region



### X3D Earth 2006

#### Origin Centric Approach

- Floating origin*: which, during navigation, maintains the observer and calculations at the highest resolution part of the simulation space
- Real world physics and navigation do not apply
- Observer stays still, world space and objects move
- Works in harmony with nature of simulation space
- Against common thinking/assumptions

### X3D Earth 2006

#### Pythagorus comes to play

- Conventional calculation incorrect:
- Error = (coord value)/(maximum mantissa)**
- Correct:**
- $$SE(3,Em,d) \leq \sqrt{3} \cdot P_2(d) - Em$$

$$- P_2(d) = 2^{\text{Floor}(\log_2(|d|))}$$
- Spatial Epsilon error
- Measure of spatial jitter



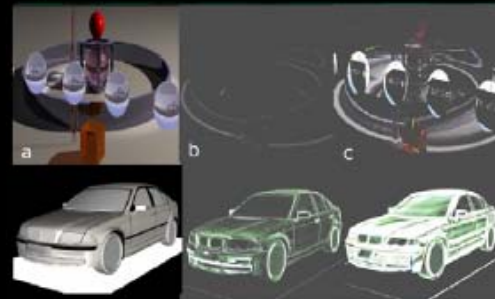
## X3D Earth 2006

- GeoVRML documents underestimate Sim error by 1.7-3.5 times
- Then multiply Pre-order and Post-order error: magnification, + TE and others

Single Precision	Max magnitude:	800000	Episodes:	1.9E-007
Double Precision	Max magnitude:	0.01E+015	Episodes:	2.20E-016
Single Precision Distance	A: Mod/Versus error (estimated/monitors)	B: SSE	C: Ratio (B/A)	
8.19E+003	0.0010	0.0069	1.73	
1.00E+000	0.1192	0.20011	1.73	
6.40E+006	0.7029	1.3913	1.73	
1.00E+007	1.1001	2.00114	1.73	
Double Precision Distance	A: Mod/Versus error (estimated/monitors)	B: SSE	C: Ratio (B/A)	
1.00E+000	1.11E-011	3.05E-011	3.46	
1.00E+006	1.11E-010	3.05E-010	3.46	
6.40E+006	7.11E-010	2.46E-009	3.46	
1.00E+007	1.11E-009	3.05E-009	3.46	

## X3D Earth 2006

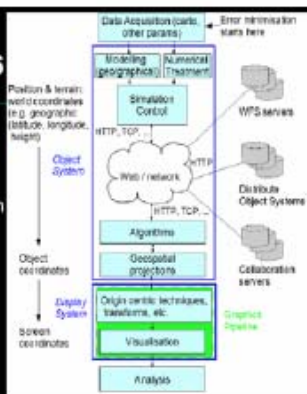
### Experiments



## X3D Earth 2006

### Error Minimizing Simulation Pipeline

- Allows for SE & Narrowing Precision Bottleneck
- Optimal accuracy throughout
- Reduced SE, calc error. Combined process and many techniques



## X3D Earth 2006

### Origin Centric Approach

- *Floating origin*: which, during navigation, maintains the observer and calculations at the highest resolution part of the simulation space
- *Lazy evaluation*: step-down in precision occurs late as possible and in a way that minimises accuracy loss (dec precision funnel)
- *Progressively refined fidelity* of object position in conjunction with LOD ensures the highest relative positioning accuracy between objects
- Floating point compression

## X3D Earth 2006

### Origin Centric Approach

- Precise dynamic placement
- Calculation of z buffer error and optimal z front/far clip planes
- *Precision function point optimisation*
- Calculation of optimal distance between overlapping surfaces
- Calculation of maximum simulation error
- An *origin centric* process

## X3D Earth 2006

Simulation quality currently depends on **where you simulate**

It should only depend on **how you simulate**  
Origin centric simulation is **position independent**

*This work is most important where it is mission critical to have a high guaranteed accuracy and numerical stability throughout a simulation environment and over a wide scale range*

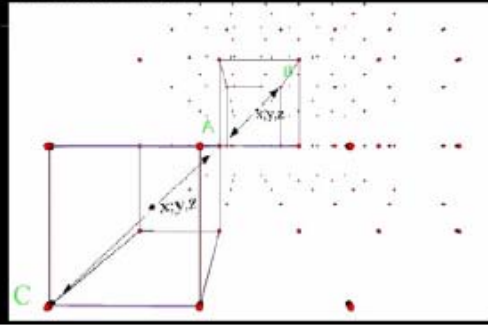


## X3D Earth 2006

- Data input from scans and stored georeffed
- From top to bottom: 3D Models on left, 2D images on right with successively larger coords
- Bottom model shows bad FP quantization, jitter & pathological diversion/conversion



## X3D Earth 2006



## X3D Earth 2006

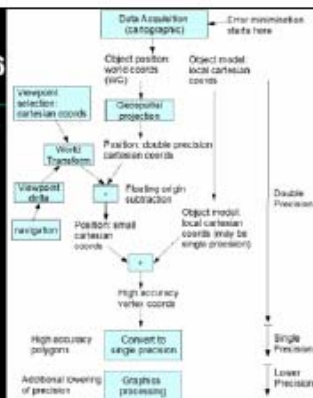
If I put a BMW in a sealed truck and drove the truck around, even though I have a fixed light and camera inside, the rendering of the BMW will change with truck's position.

## X3D Earth 2006

A better understanding of the nature of simulation space and the simulation pipeline can be used to achieve optimal scalability and fidelity throughout virtual environments.

## X3D Earth 2006

- Some steps in the life of a coord in an error minimizing pipeline
- Architecture and techniques are *origin centric*

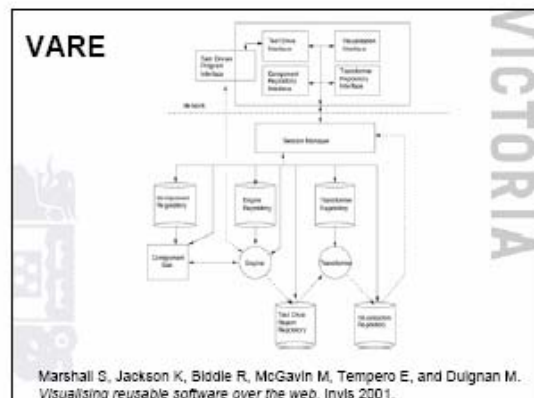
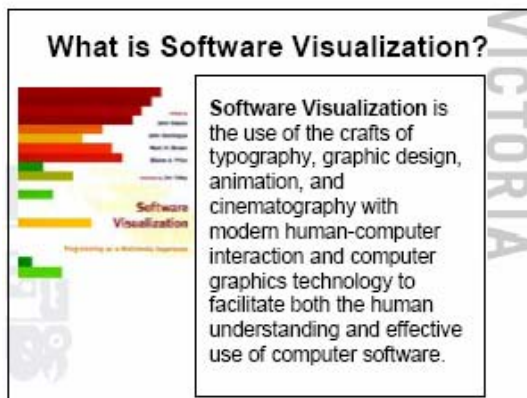
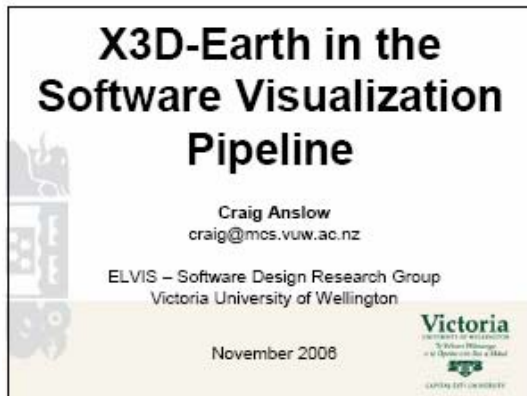


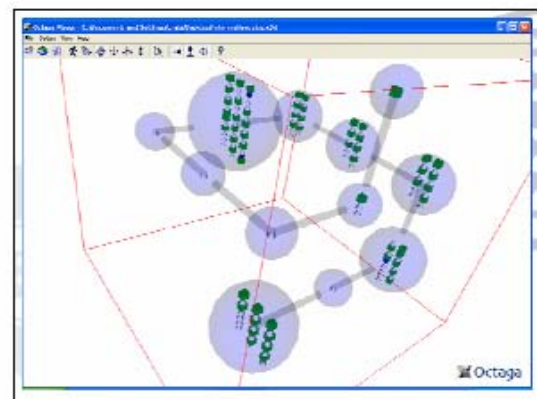
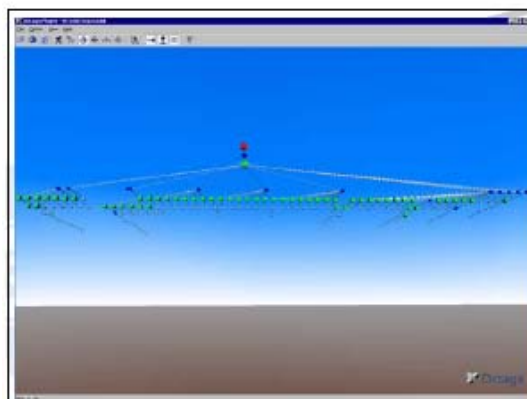
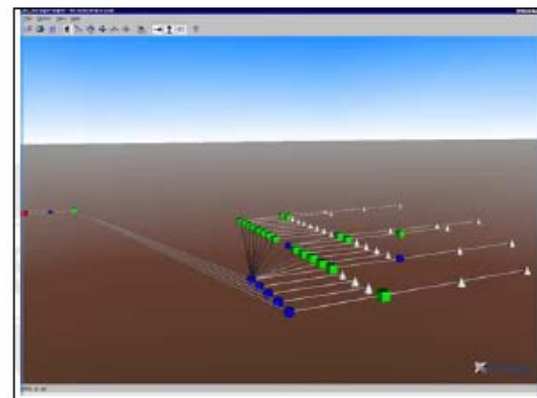
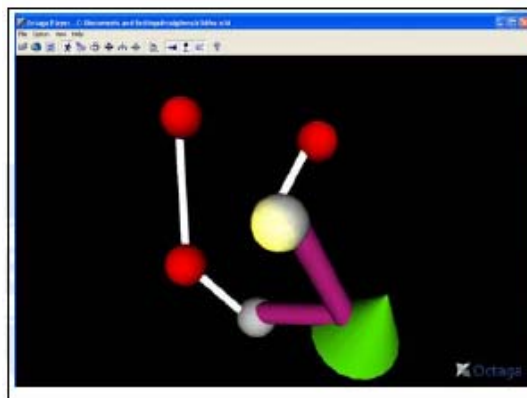
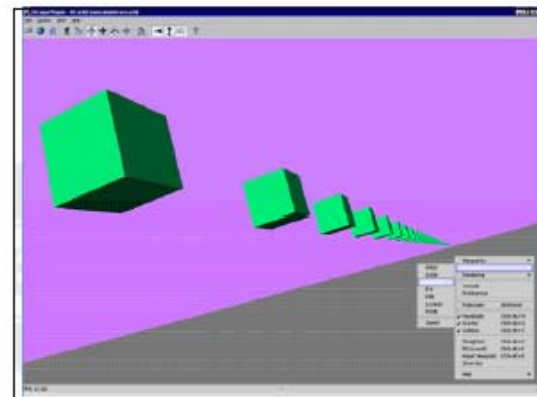
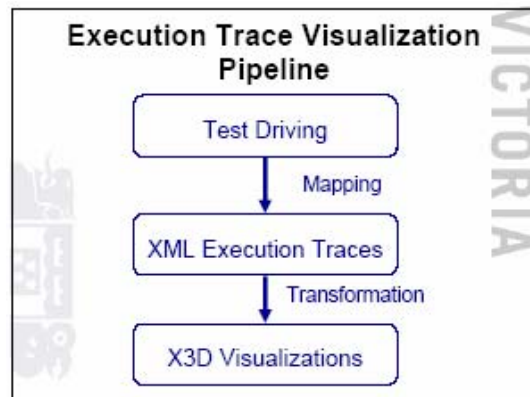
## X3D Earth 2006

- References
- Accepted for Cyberworlds 2006: <http://planet-earth.org/cw06/thome-CW06.pdf>
- To be published in the Journal of Ubiquitous Computing and Intelligence special issue on Cyberworlds: <http://planet-earth.org/ubow/thome-UBCW.pdf>
- Published in proceedings of Cyberworlds05: <http://planet-earth.org/cw05/FloatingOrigin.pdf>

## W. X3D-EARTH IN THE SOFTWARE VISUALIZATION PIPELINE

by Craig Anslow, [Victoria University of Wellington](http://www.vuw.ac.nz), New Zealand







## New Metaphors for Visualizations

3D City => Use X3D-Earth!!!

## X3D-Earth Visualizations - Requirements

- Need to be able to transform XML execution traces
- Web enabled
- How do you represent classes, objects, method calls, method returns, field access, field modifications, ... ?
- Layout algorithms
- Navigate within cities, to cities and other countries
- Easy to create
- ...

## Related Work



Knight C, and Munro M. *Comprehension with [in] Virtual Environment Visualisations*. IWPC 1999.




Panas T, Berrigan R, Grundy J. *A 3D Metaphor for Software Production Visualization*. InfoVis 2003.



Kot, B., Wuensche, B., Grundy, J., and Hosking, J. *Information Visualisation Utilising 3D Computer Game Engines Case Study: A Source Code Comprehension Tool*. CHINZ 2005.

## Partnerships

- Terralink International
- MetService
- ProjectX Technology
- Weta Digital
- Sidhe Interactive
- HITLab New Zealand – University of Canterbury
- Right Hemisphere





## Conclusion




- Building tools that can produce **X3D visualizations** from execution traces over the web
- Want to use X3D-Earth for 3D city **metaphor** visualizations
- The visualizations will help assist developers to **understand** the structure and behaviour of software

## X3D-Earth in the Software Visualization Pipeline

Craig Anslow (craig@mcs.vuw.ac.nz)  
<http://www.mcs.vuw.ac.nz/~craig>  
**Supervisors:** James Noble,  
 Stuart Marshall, and Robert Biddle\*



## X. POSITION PAPER: X3D-EARTH IN THE SOFTWARE VISUALIZATION PIPELINE

by Craig Anslow, Victoria University of Wellington, New Zealand

### 1. Interests

The information visualization research challenge is how to invent new visual metaphors for presenting information and developing ways to manipulate these metaphors to make sense of the information [1]. Using X3D-Earth in the XML visualization pipeline will enable developers to use a powerful 3D engine to create 3D web visualizations of software in a much easier manner. This kind of approach has been successfully used for source code comprehension within virtual reality environments [2] and 3D game engines [3].

We currently have a web based visualization architecture [4] which requires tools for creating visualizations of software from XML execution traces. I am interested in attending the X3D-Earth workshop as I would like to be able to use and contribute to a standards based X3D-Earth model as an engine for a software visualization [5] system.

### 2. Expertise

Craig Anslow has a BSc and BSc (First Class Honours) degrees in computer science from Victoria University of Wellington, New Zealand. The honours project involved building a reliable XML database that could store large XML execution traces up to 100MB. The application allowed a user to store and query the traces over the web. Currently I am doing a MSc thesis degree in computer science in the area of software visualization. My thesis is to investigate how appropriate X3D is for the use in the software visualization pipeline. Preliminary results have showed that X3D is a medium which can produce relatively straight forward visualizations of software by transforming XML execution traces using XSLT.

I have extensive experience using XML, XSLT, XQuery, native XML databases, and Java. I also have four years industry experience working as a web developer for Victoria University of Wellington, self employed web developer, and a software developer for a large US organisation in New Zealand working on telecommunications software.

### 3. Strategic Partnerships

In Wellington, New Zealand there are number of companies working on 3D mapping technologies that the Web3D consortium could have potential strategic partnerships with. Some of these companies are now listed.

Terralink International<sup>1</sup> provides Geographic Information Systems (GIS) and mapping solutions. Terralink was once owned by the New Zealand government but has since been privatised in 2001. Animation Research Holdings Ltd, a New Zealand company recognised globally for its innovative 3D animation achievements is an 80% shareholder. Terralink provides all the information for map publications in New Zealand and have various web applications to view this data. Terralink recently provided a tertiary education grant to a masters student in the School of Architecture and Design at Victoria University for a 3D, interactive, web enabled, multilayered model of Wellington City. The scholarship is valued at (\$15000 NZD). The recipient is currently using Google Earth as an engine to display urban environments.

MetService<sup>2</sup> provides weather and information presentation services to customers around the world. It has produced Weatherscape XT, which is the world's premier weather graphics system used by leading broadcasters such as BBC News, BBC World, Nine Network Australia, TG4 Ireland and international CNBC stations. Weatherscape XT uses 3D rendering technology, 3D graphics animation, computer technology and meteorological science to provide an automated weather presentation and production system.

ProjectX Technology<sup>3</sup> is an international online map services company. They are a startup company and have existed since July 2005. They have developed two very useful tools to make online mapping easy. The first is ZoomIn Mapping System which is a toolkit that uses Ruby On Rails and can visualise your location based data. The second uses this system and is called ZoomIn. ZoomIn is a local search website for Australia and New Zealand. ZoomIn allows you to locate addresses, find businesses or services and interesting places you have never heard about or seen.

### References

- [1] Eick, S.G. Visualizing Online Activity. *Commun. ACM* 44, 8 (2001), 45-50.
- [2] Knight, C., and Munro, M. In Proceedings of the IEEE 7th International Workshop on Program Comprehension. *Comprehension with/in Virtual Environment Visualisations*. 1999
- [3] Kot, B., Wuensche, B., Grundy, J., and Hosking, J. In Proceedings of 6th SIGCHI New Zealand Chapter. *Information Visualisation Utilising 3D Computer Game Engines Case Study: A Source Code Comprehension Tool*. 2005.
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- [5] Stasko, J., Brown, M., and Price, B. *Software Visualization*. MIT Press, 1998.

X3D Earth Requirements'06 November 14-15, 2006, Naval Postgraduate School, Monterey, California, USA.  
X3D Earth Requirements Workshop.

<sup>1</sup><http://www.terralink.co.nz>

<sup>2</sup><http://www.metservice.co.nz>


<sup>3</sup><http://www.projectx.co.nz>

**Y. NASA WORLDWIND**  
by Patrick Hogan, [NASA](#)



### What is NASA World Wind?

- An open source interactive 3D geospatial visualization tool
- Provides 24/7 access to NASA and any other data
- Integrates multiple data sources simultaneously and seamlessly



The slide features a blue background with a world map. The title "What is NASA World Wind?" is at the top. Below it are three bullet points. To the right is a small inset image showing a 3D visualization of a mountain range.

### Extensible Technology

- API architecture provides for a fully configurable client
  - Unlimited extension via plug-in
    - I.e., real-time tracking of satellites
  - Unlimited customization via XML files without any need to change the code



The slide has a blue background with a world map. The title "Extensible Technology" is at the top. Below it is a bullet point with two sub-bullets. To the right is a small inset image showing a satellite in orbit over Earth.

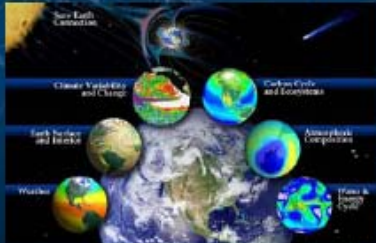
### Data Delivered (short list)



The slide has a blue background with a world map. The title "Data Delivered (short list)" is at the top. Below it is a collage of various data visualizations, including satellite imagery, maps, and 3D models. The central image is labeled "NASA World Wind".

### Earth Science

- NASA Geospatial Interoperability Office (GIO) competitively selected World Wind to deliver DAAC's 3D data



The slide has a blue background with a world map. The title "Earth Science" is at the top. Below it is a bullet point. To the right is a collage of Earth science data visualizations, including climate maps, satellite imagery, and 3D models.

### Current DOD Collaboration



The slide has a blue background with a world map. The title "Current DOD Collaboration" is at the top. Below it is a collage of military and defense organization logos, including the Department of Defense, Joint Chiefs of Staff, and various military branches.





**Open Source Benefits**

- **Enhanced Software Quality**
  - Extensive new features/functionalities and user support from the OS community
  - Extensive testing of new and existing features on a wide range of hardware configurations
  - Bug identification, tracking, and resolution
  - Absolute security regarding code activity
  - Unlimited ability to extend functionalities

Small text at the bottom: EE M/learning Technology - World Wide

**Conclusion**

- Provides the standards-based platform for rapid expansion of the **geospatial information delivery infrastructure**
- Leverages entrenched technology, based on open standards, just as with the first generation web browser, but now for 3D data
- Allows for unlimited customization and commercial opportunities via plugin architecture
- Inter and intra-agency communication is enhanced in being immediately adaptable to data access needs and situation requirements

Small text at the bottom: EE M/learning Technology - World Wide

## Z. MULTI-IMAGE SUPPORT NEEDS

by Leonard Daly, [Daly Realism](#)

### Multi-Image Support Needs

#### Presentation to X3D Earth Workshop

14-15 November 2006  
Leonard Daly  
President, Daly Realism

### Outline

- Uses
- DataSources
- Users
- Requirements
- References

### Uses

- Climate Research
- Land Use Planning
- Military
  - Target Identification
  - Mission Planning
- Intelligence
  - Monitoring
  - Treaty Compliance
  - Surveillance
- Law Enforcement
  - Disaster Planning & Execution
  - Activity Detection

### Data Sources

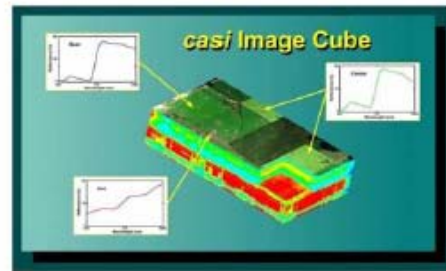
- Pan-Chromatic (B&W)
- Multi-spectral (Visible to NIR)
- Hyper-spectral (hundreds of bands)
- Thermal
- Synthetic Aperture Radar (SAR)

### Data Sources - Multispectral




Multispectral image of Southern California sat 25 Oct 2005. Red pixels are active mining regions detected with a thermal sensor. Black pixels are previously burnt regions.  
Images from NASA - GlobalLand Cover Project. Center for the Visualization of Earth Data  
<http://www.globe.gov/index.html>

### Data Sources - Hyperspectral



Hyperspectral cube used for precision farming in Manitoba, Canada. Cuts show the spectral responses of a single ground pixel.  
Images from Natural Resources Canada <http://www.nrcc.gc.ca/>



SAR Capital Eviction Order (CEM) corresponding to CTEC-4 of LaCueva High School in Albuquerque, New Mexico. © 2006. Sandra. Image from RFLY SAR. <http://www.sandra.gov/FLADARfly.html>.

## Data Sources - Merged



Merged SAR image of the United States and Multispectral image of southern California highlighting the 2001 fire.  
SAR image from Canadian Space Agency <http://www.space.gc.ca>

## Models - San Francisco



Building models in San Francisco merged with terrain and ground cover.  
Microsoft Virtual Earth images © 2006, Reuters.

## Models - Seattle



Building models in Seattle merged with terrain and ground cover.  
Microsoft Virtual Earth images © 2006, Reuters.

## Users

### Small Sampling of Users

Organization/Function	Type	Role
Canadian Space Agency	Canada Govt.	Imagery (SAR) supplier
NASA	US Govt.	Imagery supplier, Developers, Users
National Reconnaissance Office (NRO)	US Govt.	Overhead reconnaissance data supplier
National Geospatial Agency	US Govt.	Analysis and use of imagery, maps, and other geospatial information
Fire Departments	Local, State, and US Govt.	User for fire prevention, control, and fighting
Drug Enforcement	Local, State, and US Govt.	User for crop detection and smuggling
Local Zoning & Urban Planning	Local, Educational	Developer, User
ESRI	Commercial	Developer (ArcGIS suite)
ORBIMAGE and GeoEye	Commercial	Commercial data supplier
Research Systems, Inc.	Commercial	Developer (ENV)
Utility Companies	Commercial	User

## Requirements

- Image set manipulation
  - swap
  - merge
 Support interactive study of multiple images from a variety of collection systems.
- Texture with overlapping multi-resolution imagery
  - Support location area studies and provide contextual references.
- Handle imagery collected over time
  - Support visual change detection studies.
- Read, process, and display multi-band images
  - Support interactive studies of multi- and hyper-spectral imagery.

## References

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- Canadian Space Agency (<http://www.space.gc.ca>).
- Center for Remote Imaging, Sensing and Processing (CRISP). Principles of Remote Sensing ([http://www.crisp.nus.edu.sg/~research/tutorial/opt\\_int.htm](http://www.crisp.nus.edu.sg/~research/tutorial/opt_int.htm)).
- NASA: Goddard Space Flight Center Scientific Visualization Studio (<http://svs.gsfc.nasa.gov/index.html>).
- NASA: Jet Propulsion Lab (<http://photojournal.jpl.nasa.gov/>).
- NASA/GSFC/METI/ERSDAC/JAROS and U.S./Japan ASTER Science Team (<http://asterweb.jpl.nasa.gov/>).
- National Geospatial Agency (<http://www.nga.mil/>).
- National Reconnaissance Office (<http://www.nro.gov/>).
- Natural Resources Canada (<http://www.nrcan.gc.ca/>).
- ORBIMAGE (<http://www.orbimage.com/index2.htm>).
- Reuters (<http://reuters.com/>).
- Sandia (<http://www.sandia.gov/RADAR/rtv.html>).



### **III. CANDIDATE TECHNICAL REQUIREMENTS**

#### **A. INTRODUCTION**

This chapter presents a long and detailed list of candidate technical requirements for X3D Earth. This list was generated through an extensive email dialog held on the Web3D Consortium mailing lists and during weekly X3D Working Group teleconferences. Discussion moderation and requirements compilation was performed by Alan Hudson, Web3D Consortium President.

#### **B. PROPOSED TECHNICAL REQUIREMENTS**

The below is excerpted from Alan Hudson's X3DE requirements white paper.

The authors propose that the following requirements be adopted for the X3D Earth initiative:

1. Provide a seamless space to face viewing experience of the Earth
  - Allow the user to go inside the Earth as well as view subsurface data like well and mine data
  - Local override of terrain mesh and imagery desired
    - Allows a proposed construction site to show changes
  - Bathymetry data should be available
2. Each participant should contribute computing resources
  - Bandwidth
    - p2p distribution of assets
  - processing
  - storage
3. Server Requirements
  - Provide a reference Server Architecture
  - Provide at least one Open Source Implementation
  - Multiple versions of X3D Earth should be possible
    - Chain of materials, but local servers can override a resource
      - Web3D provides a base level resource for terrain and imagery
    - Allows the distribution of private data, i.e. classified sources, commercial data warehouses

4. Client Requirements
  - Provide at least one open source implementation of an X3D earth client
  - Easy navigation
    - Planet centered navigation mode
    - Ground level navigation mode
    - Subsurface navigation mode
5. World State
  - Provide a mechanism for distributing world state
    - Example: Is a light turned on?
6. Chat System
  - Chat areas divided by some mechanism—perhaps regional divisions.
7. Display of Volume data registered to Terrain data
  - ISSUE: How to render geospatial correct, typically a cube but needs be a frustum?
  - NASA Use Case: Underground scans for possible moon base
  - Planet 9 Use Case: Animated weather/dispersion display from simulation in a city
8. Community-provided object authoring
  - Provide an easy art path for users to create content
  - Voting System to bring best assets up / avoid spam
  - Multiple overlays of data/objects subscribable by user
    - Enable data vendors for overlays like 3D Buildings, GIS information
9. Enable client implementers to differentiate themselves
  - By how well a layer is rendered?
    - For example, tree coverage (color, texture map, 3D objects)
  - Could have conformance issues.
10. Enable multiple planetary bodies to be viewed
  - Up to the Solar System scale
  - NASA Use Case: Be able to show a complete earth to mars mission
  - Show exploration missions on asteroids as well for mining
11. User selectable truth or synthetic view of data
  - Any derived visualizations should be controllable by the user so the raw data can be seen
12. Data Fusion
  - Easy to combine multiple data sources on top of the world

- GeoRSS overlay is a good example
- WMS/WFS/WCS Support
- Positioning of GeoTIFF files
- KML file display?
- Can either directly support some of these or make sure the API's make it easy
- Ability to import/merge DWG and IFC files
- This might be a conversion to X3D or directly inlining

13. Ability to represent building internals

14. Semantically markup items to enable smarter agent behaviors

- Example: denote what are doors/windows/stairs
- We are not sure what ontologies to use
- Should we create as a layer so the client can request different versions?

15. Drive users to download X3D players by compelling content/experiences

- Should we adopt a game principal of scarcity to keep users coming back?
- Highlight the 5 best data streams (attention)

Question to be Considered:

*Should the streaming function be streaming for earth, or a more generic technology for streaming geometry and textures?*

## **C. CONTINUING GROUP INPUTS TO THE REQUIREMENTS**

Provide a seamless “space to face: viewing experience of the Earth.

Allow the user to go inside the Earth as well as view subsurface data like well and mine data

Local override of terrain mesh and imagery desired

Allows a proposed construction site to show changes

Bathymetry data should be

Data Compositioning

Easy to combine multiple data sources on top of the world

GeoRSS overlay is a good example

WMS/WFS/WCS Support

Positioning of GeoTIFF files

KML file display?

Can either directly support some of these or make sure the API's

Time presentation

- can I see the world as it was in the past?

LIDAR data conversion to X3D

Embed identify and trust into the chain to be able to validate the final

DRM has a role to play here

The ability to display the provenance of data

Reprojection on the fly important

Fusing different world project images

Issue: Combination of flat-earth and curved earth datasources

Measure and query geometries

There are many 2D projections from spherical to flat. Perhaps unnecessary when rendering to 3D, but they represent surprising possibilities. Also pertains to unwarping collected data.

Carbon Project: <http://www.thecarbonproject.com>

Free VMS viewer

Need pagable

Better hyperlinking to other worlds, sources of information

More information available. May not be graphical information

Annotations

How to describe?

## **IV. PARTICIPANT DISCUSSION EXCERPTS**

### **A. OPENING REMARKS AND INTRODUCTIONS (DON BRUTZMAN, NPS)**

### **B. DOUGLAS MAXWELL (NUWC)**

Q. What are the dependencies on GeoElevationGrids?

A. The GeoSpatial libraries.

Don B. – Certainly, the implementation of X3DE is feasible for bathymetric models, as demonstrated by your work. Getting the right design patterns for large archives of server-side data assets is crucial.

### **C. MIKE MCCANN (MBARI)**

Q. Have you considered converting all of your scenes from Virtual Reality Modeling Language (VRML97) to X3D?

A. Yes, of course. However, navigation modes are an issue. Cosmo player's navigational modes are desired as other browsers do not support walk do to the up vector not normal to the earth's surface.

Mapping 2D to 3D, maintaining orientation is crucial. Choosing your own particular viewpoint will need to be considered.

Monterey Bay Aquarium Research Institute (MBARI) is using GeoVRML as a Production Application, Netscape + CosmoPlayer and GeoVRML (about 10 years old now); scripted with VRML. Used by MBARI scientists in daily conduct of ocean exploration.

### **D. DR. JULIAN GOMEZ (POLISHED PIXELS)**

Q. As X3D Earth connects to proposed standards, will people be able to access and use these technologies?

A. Absolutely

**E. DR. RICHARD PUK (INTELLIGRAPHICS, INC.)**

Q. What is the relationship with European Petroleum Survey Group (EPSG) codes?

A. Spatial Reference Model (SRM) templates can be used to map. SRM can handle both ellipsoids and the WGS84 geoid.

Q. Has the Synthetic Environment Data Representation and Interchange Specification (SEDRIS) begun to use XML?

A. They have begun mapping some datasets to XML. See <http://discussions.sisostds.org/default.asp?action=9&fid=19&read=4930> and <http://discussions.sisostds.org/default.asp?action=9&fid=19&read=4932>

**F. TONY PARISI (MEDIA MACHINES)**

Q. You talked about the browser plugin, but you also talk about the browser application itself.

A. Yes, the plugin allows you to visualize a scene, but the browser application itself allows you to author scenes and view them. The two come packaged together.

Q. I know you are tied to Asynchronous JavaScript and XML (AJAX) and how it relates to Web3D and how it communicates with Flux Studio. Are you into any other technologies for X3D support?

A. Think of AJAX as a glue layer in building an X3D scene, but only a piece of the toolkit. Popular applications such as Google Earth and SL are not platforms even though people are trying to make them bigger than they are.

The Ajax3D mailing list now has 150 subscribers. Ajax3D a part of Flux Studio, but not a huge part of Ajax3D is used for graphics.

Q. What's your view on JavaScript for performance as compared to other performance-related scripting languages?

A. Flux has a very optimized JavaScript engine. Further optimizations can be performed. Performance is excellent and matches real-time 3D requirements.

Q. Do you like that we now have both an EcmaScript and a Java™ Scene Access Interface (SAI) for authoring scenes?

A. It's a great way to experiment with extensions to each and how to map these to each browser.

Q. What's the relationship with Collada and X3D? There is a converter now.

A. A joint story is emerging and is complementary. Web3D Consortium is working on memorandum of understanding (MOU) with Khronos to permit shared efforts to proceed together.

**G. NICK POLYS, VIRGINIA TECH (VT) SLIDES (DON BRUTZMAN MODERATOR)**

Requirements: Speed, federated applications, an Application Programmer Interface (API) to expose scenegraph nodes. Immersive and gigapixel display; e.g. head and device tracking for gestural and 3D device tracking.

**H. SONALYSTS, INC. QUESTIONS POSED TO THE GROUP**

Q. Are there any Light Detection And Ranging (LIDAR) datasets releasable?

A. There is an extensive set of Gulf Coast datasets available to the U.S. Government.

Q. Photogrammetry, LIDAR, and manual surveys are all methods for gathering raw data for X3D simulated environments. Are there other methods? Can you describe them?

A. Eric Turpin <[eric@geovrml.com](mailto:eric@geovrml.com)> Solutions are quite different depending on your actual needs. Main classifiers are area, precision, and speed. Secondary classifier is qualification of raw data. This qualification helps a lot when designing VR scenery. And, once again local culture/architecture: to be caricatural, the area of U.S. skyscraper doesn't call for the same approach as a chemical plant or as an Australian aboriginal leaving place.

### Photogrammetry and LIDAR:

Good for large areas, and quite fast. Precision takes much longer time. One needs to eliminate all vegetation in order to reconstruct architectural shapes, and classifying information is very scarce: producing a usable VR scene out of LIDAR data proves to be a long job: you end up with an unqualified single mesh: setting apart buildings, pavement, stairs, sign posts, ground level detail (think of shops marquises ...), and, unless you have access to oblique shots, you only have the roof and pavements textures to drape the buildings with. In the end, this is very man-labor intensive.

Manual survey isn't designed for speed, or for large areas, but beats any other method when it comes to actual 'pertinent' accuracy and qualification of shapes. It gives access to data unavailable thru airborne

LIDAR/photogrammetry: buildings sides, and qualification:

Another method (depending on the need) is ground based photography (or very low altitude, think drones or any low altitude aircraft or balloon), coupled with range measurement and Global Positioning System (GPS) (including referential ground GPS point). There are several setups possible to do this, I even witnessed a 'hat' made of six cameras a guy was wearing while walking in the street...

I'd recommend a more stable mounting :), though it was interesting as a qualification system: you even had the local pedestrian types (market area, offices area, work place, etc ...), car traffic (intensity, type), etc...

Depending on the need, I wouldn't recommend either single method, neither for speed, nor for accuracy, nor for leveling human touch. Final use target decides.

One thing for sure: only a fool wouldn't use a GIS system to gather the data. And that's where leveling may take place in the treatment/gathering/productions steps processes. This is the only real way to use available data (qualifiers, basic structures, etc...), cross it with produced data, and mix the whole. That the nodal point where cumulative effort takes place, and where the most attention has to be put, in order to convert a point cloud into a leaving place...



Once again, different quick and automatic methods for producing X3D methods do exist: take a LIDAR point cloud, consider it's 2.5 D and triangulation is fast and easy, drape it with aerial photography, fill the missing building faces with generic textures, and your done, at the expense of accuracy and optimization. On the other hand, find a city map, or digitize from aerial imagery the buildings footprints, if height data isn't available as a polygon qualification, it may be fast to add it, just by evaluating floors numbers, extrude it, and your similarly done, with sometimes better accuracy (think of the vegetation and LIDAR), and far much 3D optimization.

Of course LIDAR data may be automatically 'cleaned', that's part of the usual commercial package offered by the guy doing the work (data roughness in vegetation area is easily spotted, lampposts artifacts are easily removed, etc...), decimation may be undertaken using specific algorithms. I had to work with such raw data: a 0.1 meter point cloud of a city. I could see in the point cloud the paper bins in the streets (and, I think, a dog honoring one), and the engines of the airplane leaving the airport. A few statistical steps further (local deviance, roughness mostly), a few decimation steps further (with conservation rule based on the statistical analysis), and I ended up with a quite good model for fly throughs (<http://www.geovrml.com/eng/index.htm>) - sorry, the site hasn't changed since last century - find your way to 'Galleries' (bottom) -> 'urban models' (left), see 'Monaco'), but certainly not for pedestrian walkthroughs. Geometric distortions/inaccuracies where too high, so I had to spend a lot of labor before it reached the walkthrough standard.

Now there maybe are, nowadays, better algorithms for decimation and auto qualification... but still, imho, the road is long from LIDAR to a Ultra High Resolution Building (UHRB)... so the answers are lying in the projected use.

Q. What is the quickest method to convert a raw data set (a LIDAR map for example) into X3D models? The most accurate method? The best method?

A. Len Bullard <[cbullard@hiwaay.net](mailto:cbullard@hiwaay.net)> Isn't one approach to use LIDAR in combination with time-stamped video where both are sampled simultaneously from the

same or multiple units? It is still messy, but easier for manual annotation later by a human who can review it and put in the first pass or multiple passes.

Speaking of photo mapping, there is a program on the History Channel here in the States where collections of pre-post and during the event aerial battle photography is mapped to the 3D terrains to demonstrate the history of the battle. This use of 3D for historical visualization based on archived high resolution resources is very effective.

Q. Can X3D models be automatically created from raw data, that is with little or no human interaction?

A. NPS tools have produced several exemplars. The Rez tool by Ping Interactive is another good example.

Q. How was the Pearl Harbor map created?

A. Refer to the NPS Modeling and 3D Visualization for Evaluation of Anti-Terrorism/Force Protection Alternatives Phase II Final Report Appendix G (Brutzman et. al., 2006).

## **I. RAJ SINGH, OPEN GEOSPATIAL CONSORTIUM (OGC)**

Q. Do you have a slide of the OGC references to give people an idea of what the OGC stack is?

A. Web-mapping service, an API to give you back an image from a location you specify. Web-coverage service (WCS) gives you back other requested resources. Web-catalog service – symbology libraries. OGC started with database geo standards.

Two big efforts: geo standards (new relationship with W3C), interoperability test bed- very important to their members.

Covering Geography Markup Language (GML)/City GML (to describe urban environments)

Web Terrain Service

CAD-GIS (geo information systems), BIM (building information models)

Google/Sketchup integration

CAD culture different from GIS/BIM technologies. Lot of effort to get them to work together.

Seamless semantics important to GIS apps.

Client gets data from a lot of different sources put into a federated database

Services: web mapping (2D), web feature services (vector service), Web coverage service (any data), web catalog service (in process to be defined).

Q. What is your take on where or how this project (the X3D part) will look to OGC members?

A. Time is right for 3D geospatial. Baseline is done. Sensors, digital rights management (DRM), CAD based data. GeoRSS is simplest way to communicate geo vector data, and a popular movement at OGC.

People have had such a hard time with information management, search and discovery issues... SensorML, sensor services and DRM are areas that are hot.

Q. How do you feel about other APIs like Google Earth?

A. We are working with other folks on how to come up with similar standards in order to simplify efforts.

## **J. CHRIS NICHOLAS, PLANET 9 DESIGN STUDIOS**

Architecture Visualization

Early VRML adopter

Imagery and data change quickly

Proprietary viewers: GlobeXplorer, Yahoo®, Google and Microsoft®

Teleatlas, Navteq, 3D (Planet 9, rigged characters, etc.)

3D: graphics APIs vs. sensors need to be explored!! good points.

Sustainable ecosystem: the goal.

**K. DAVID BEARD, GEOSCIENCE AUSTRALIA**

Q. Silly question, but what time is it there?

A. 0850 on Wednesday the 15<sup>th</sup> of November.

Participant comment: Seems that when we get a dedicated working group assembled that we will be working across time zones consistently.

Q. (Question about server load/capacity for data)

A. If we develop open-standards, Google Earth™ may attempt to play. Google Earth™ has a LOT of servers that can pump out data streams consistently, so we will have to deal with that capacity demand as that is what our customers will expect in delivery.

Participant comment: NPS has agreed to host a cache of servers that will be made available to the working group and eventually the open public. Perhaps some companies will donate server assets.

Q. Do you talk to Google at all (to Don Brutzman).

A. Yes, we've had several discussions with Google. We were across the show floor at SIGGRAPH this year and have had good discussion with Michael Jones, head of Google Earth™. They intended to send somebody this week, however, they are busy with other projects at this time.

Participant comment: It's interesting that your browser has OGC capability embedded. Exposing an existing set of VRML assets in your application may be more attractive than attempting to convert to SML formats and such. Google Earth™ is moving to an OGC set of standards as well. It would seem prudent to keep in the VRML standard and not spend time converting to other standards.

As a minimum, we could have a flag that will allow for a projection in another earth frame embedded in Google Earth™.

It would seem to me that we could have a global set of servers that will accommodate an X3D Earth environment and have that posted to the web which will have an advantage over a KML format as it will be more accessible.

**L. DALLAS MEGGITT, S&ST**

Q. How much utility and value does 3D add over 2D?

A. It adds a heck of a lot, at least by a factor of 2. Add to the user's visualization of various data fusions. Multi-screens are nice, but lack dimensionality. Computers are equipped to provide rendering cheaply and plentifully. People who hold the money pockets, much more impact will be delivered, i.e. visualizing a red team penetration into a base. Ingress/egress routes are better understood.

Q. In your data fusion work, do you assign confidence intervals to your merged totals?

A. Yes, a variety of detailed analysis occurs.

Participant comment: NPS will show how we do this in a current application. Well defined statistical formulae can be applied to produce meaningful information from simulation data.

GIS plays a key role in their efforts. Everything they do is geo-referenced. Example: Vehicle Based Improvised Explosive Device (VBIED).

GIS provides the "common" foundation in common operating systems.

X3D requirements: compatibility with Environmental Systems Research Institute (ESRI) files, ease of use, ease of changes in GIS.

**M. SHUN-YUN HU, NATIONAL CENTRAL UNIVERSITY TAIWAN**

Q. Have you considered quality of a Peer-to-Peer (P2P) approach where the server essentially has no control over the quality of the peers?

A. Quality of streaming can be ensured through matching up a requester with the best serving peers. It's done by a de-centralized approach where the client determines

where it connects. For example, in BitTorrent, each peer keeps 5 download connections from a pool of 40 potential serving peers, and a random switch every 30 seconds helps to discover the best serving peers. Although it's a randomized approach, it turns out to work fairly well.

Q. What about methods to allow commercial vendors to provide terrain dataset and restrict peers to get data only from other peers that have signed on with the server?

A. It's possible to adopt a centralized login for P2P systems. There are existing schemes where a peer can sign on with a centralized server to get a timed certificate, which can then be verified by other peers to ensure that only authenticated peers can communicate with each other. The server is also required only during the initial login. Commercial adoptions for P2P should be possible.

Participant comment: we can allow a commercial vendor to supply terrain data, then overlay datasets on top of the base terrain.

Q. There's a widely used presence protocol called Extensible Messaging and Presence Protocol (XMPP), Jabber Chat Standard, have you used XMPP? How does it compare with customized P2P protocols?

A. Not familiar with XMPP as of yet.

Participant comment: we have some co-homework to do together then.

Participant comment: X3D Earth should allow distributed servers. It should allow anyone to provide their own data service, which ties to the P2P approach. You might have a few servers to serve the base global data, and a distributed approach could relieve loads from a centralized server.

A. When P2P is designed well, servers should only serve the data once, other peers will take care of the serving afterwards, relieving the servers from being a bottleneck (whether centralized or distributed servers).

Q. Do you have a sense of how long it takes to flush the queue in the context of new terrain data (within an hour, or..)?

A. The time to release new data to users depends on two factors: how much data to be updated, and the amount of server-side bandwidth.

Participant comments: the question was more about if there are new contents, can there be a versioning scheme so that peers can know that they should replace the old contents?

A. Simple versioning scheme can be added for content update purposes. One thing to note is that update in fact occurs incrementally, as a peer only has limited view of the global data. In that sense, even updating entire new contents wouldn't be that bad in terms of the bandwidth requirement.

Participant comments: biggest issue: scalability analysis

P2P approach: promising for scalability, see paper in the Institute of Electrical and Electronics Engineers (IEEE) Network publication, July 06 (Shun-Yun Hu, Jui-Fa Chen and Tsu-Han Chen, 2006).

Great point: make X3D Earth the social experiment for Virtual Worlds and environments. Multi-user is easily extensible with P2P.

**N. DR. J. MARK PULLEN, GMU**

Q. Is Battle Management Language (BML) as subset, or a superset of Joint Consultation Command & Control Information Exchange Data Model (JC3IEDM)?

A. No, BML is not, it is a separate standard being work by SISO, the same people working Distributed Interactive Simulation (DIS) protocol and High Level Architecture (HLA). BML is an unambiguous language that is both human understandable and C<sup>2</sup> systems readable.

Q. Was there a broad goal of interacting with industry for this project, or a specific partner?

A. The philosophy is a broad goal. ESRI is one partner that is interested in working with us interactively.

Q. What is CJMTK?

A. Commercial Joint Mapping Toolkit (CJMTK), specially licensed version of ESRI ArcView tools for government use.

Participant comment: There is high-level interest for NPS students to work with BML as this will directly apply to field officers and how they can interact.

Participant comment: Network Education Ware (NEW) is part of the old Multicast Backbone framework, with a floor control wrapped in Java to display and interact with. Uniform Resource Locator (URL): <http://netlab.gmu.edu/NEW>.

**O. CHRIS THORNE, PING INTERACTIVE**

Q. When you say that you moved a scene 150 meters, did you shift every vertex within your error-minimizing software engine?

A. Yes; and that includes the lights, camera as well as the distance. Errors are produced when moving scenes away from the origin, but are reduced when moving them closer to you actually.

Q. In terms of the scale of planet earth, how many meters before vibration (errors) occurs.

A. About 1000 meters. It starts to get noisy between 10 and 100 meters.

Participant comment: it might be good if the floating-point algorithms were embedded and tested using Extensible Java-based 3D (Xj3D) rendering.

**P. NASA WHIRLWIND**

Download and source code URL: <http://worldwind.arc.nasa.gov/download.html>

**Q. ROB GLIDDEN**

Participant comments: Rob Glidden makes some good points for identifying user communities for X3D Earth and how maps and mashups come into play. Map APIs today do not allow you to do anything web like search inside Google.

Are we talking about a service or infrastructure product?



## **R. DISCUSSION OF TOPICS FOR DAY TWO**

Q: Should we call this project X3D Earth since this may cause controversy with Google Earth™?

A. Doesn't seem to be a controversy, each is different and precisely named. Overlaps and interoperability are good things.

Q. Dallas – What about subsurface? There is a lot of complexity in this realm?

Participant comment: different parts of earth: land, sea, space, etc., should be represented. Ocean data, especially subsurface terrain, are not represented in Google Earth™ but should be in X3D Earth.

Participant comment: we don't have a large amount of research money to go forth in order to implement all of these features, so we will have to go forth and accomplish what we can with what we have. Working together helps.

W3C GeoSpace Incubator <http://www.w3.org/2005/Incubator/geo/charter> - an exploratory group that could be of importance to this effort. This may be a great organizing principle and should be part of our outreach effort - OGC's Raj Singh one of the chairs.

GeoIQ was mentioned as a map-layering application that may be another possible resource to choreograph scenes.

## **S. GROUP REACTIONS TO DAY ONE PRESENTATIONS**

### **S.1 Chris Anslow**

How do we work with the project? Technical aspects of this project, deadlines imposed on ourselves, determining a clear goal of what we wish to achieve over the next two years.

### **S.2 Mike McCann**

Mentioned the GeoVRML project and it's likeness to this project. This project tackled a big problem, but failed to hit that sought-after "sweet spot" in creating X3D

scenes with solid geospatial reference frames that perform conversion automatically. Authors and programmers like an application that be can used and/or extended from other applications. We need to define specifications that will help the end user.

How to join and engage end users? Group, repositories and codebases discussed.

What milestones and deadlines over the next few years are required? Today's cool tools are still missing generality of GIS + Generalized 3D + information + web services. End users want a constellation of applications; an ecosystem/platform they can use, both for general and advanced users.

Advanced end users become content developers even regular-user content needs to be verified/verifiable. Generalized 3D UI issues for the end user navigation are very important. An advanced end user can add their own 3D authoring tool results without being a programmer and may want a seamless transition from out doors to indoors, go inside a building, etc.

### **S.3 Chris Nicholas**

We need to distinguish ourselves from consumer-driven applications put out by Microsoft, Google, etc. We need to be able to publish in the spirit of W3C. The level of metadata, chain of trust, decision support... if we can balance that between the cadre of 14 year olds immersed in this stuff with what we see as needed.

We won't have just one Earth point, but a cluster of various points to deal with.

How to gain critical mass, survive and grow over long term

- tension between simplicity and sophisticated engineering
- market forces of big player with costly assets needed
- chain of trust for data pedigree, modification, distribution providing well-understood mechanisms when/where needed

Provide guaranteed, well-understood mechanism for where data came from. Google Earth does not really tell me any detailed accurate sources to validate data.

Also, WMS textures, W3C, OASIS may have an important impact.

#### **S.4 Toni Parisi**

It is important to emphasize Web Service Architecture (WSA). We need a new and improved scene graph that has good navigation, shader support, tile support and a solid support in SAI codebases. This is a big endeavor, but I'm ready to begin work on this. We need a new and improved scene graph; specification + best practice content + players. We need to be able to go indoors when within a scene, go down a mine-shaft... to be able to go about seamlessly anywhere around in a scenegraph. Improved navigation modes: wide range of contexts, consistent implementations

Do no harm, do not break existing success (e.g. explore indoors).

Policies and checking for inclusion of content in shared worlds

- but these may be specialized applications of shared X3D Earth assets

Use X3D as rich-media technology in our daily work (Microsoft PowerPoint™, Open Document Format, etc.)

Physics and rigid-body components will someday be added to X3D specifications, which will be able to render gravity-influenced objects.

Web3D should not take on the responsibility of heading a project that will go head on with Microsoft® and Google Earth™ against our proposed project.

#### **S.5 Jeff Weekley**

Creating content that the user community can use, complete with quality assurance and verifiable, will be important. Editorial control will be key. Building measurements, stylistics, pixel resolution on an acceptable texture as well as integrity, accuracy and relevance tied to X3D Earth elements.

Enforcing standards on buildings will be needed without stifling creativity.

## **S.6 Raj Singh**

Cultural differences GIS, 3D communities and efforts

- this is good/complementary
- lots of opportunity to do things right
- don't lose or break goodnesses when composing these worlds.
- baseline architectures are different, and difficult technical work is needed

to integrate

- maintain performance

Streaming is big area, big hole

- predictive data loading, multi-resolution
- classic P2P/multicast
- Web Services XML SOA
- XML Chat (in between)

OGC has talked about how to market what they maintain, and make results openly accessible to the public.

Participant comment: Amela Sadagic reports that Internet2 has a broad community of practice already that includes both research and industry; some patterns for success may pertain. <http://www.internet2.edu>

## **S.7 Lessons Learned**

Defining requirements for authentication (certificates, etc.) is important up front, several security-related technologies pertain.

- W3C XML Security
- OASIS WS - \* specifications related to Web Services
- Others? (mostly proprietary, unlikely)

Internet2 has a community of practice already, Shibboleth Internet2.edu

Michael Moody: Maintaining user friendliness will be key along with practical performance. Be careful of adding new features as this will change an already familiar interface. Users will want to go to their “spot” very quickly and navigate from that point, zoom in quickly and retrieve data. Google Earth™ provided good example of not compromising this essential requirement. Baseline standards need to address ease of use from the get-go. For example, a user-friendly Camera model should be part of this baseline standard.

Q. Is this definable, testable, guaranteed repeatable?

Q. Is this a specification issue or an application requirement?

### **S.8 Don McGregor**

Can't specify requirements for every kind of information that is desired. Need a framework to GeoReference diverse data, some known, some unknown.

- probable lessons learned from GIS approaches to layering and cross referencing
- Semantic Web is yet another option/perspective on this issue

### **S.9 Rob Glidden**

Hardening of the Guru's and established communities – the inflammatory problem needs to be avoided.

The hope and promise

- rapid progress and exposed capabilities demonstrated by Google Earth
- Is player really the compositor of everything of interest?
- The world is bigger than the WWW, not lesser than

Embrace open layer of web services architecture

Invert scene graph paradigm

- scene graph is part of a larger world of interaction/interactivity
- we are contributing to emerging combination of many efforts

- we are not digesting/internalizing others standards and capabilities

Need to be careful about becoming part of the solution and not add more problems to the “problem space.”

Go look at [openlayers.org](http://openlayers.org). Likes what Tony said about user requirements being crucial and builds on what Tony says. Meta concept: Web Service Architectures are not the whole world, open layers are a good thing to investigate. Rob suggests inverting the scene graph paradigm, look at GUI. An interesting X3D GUI is not necessarily an X3D browser. He thinks Web services aren't the end-all and that web browsing as we know it today may not be the paradigm to view virtual world, earth, etc. in the future.

Scene graph and metaverse world role: typical presentation says that a metaverse world needs to fit into a scene graph, not the other way around. I don't get that. That doesn't support what he was saying IMHO, because fitting a metaverse into a scene graph still motivates the browser paradigm to view the metaverse.

We need to pay attention to the some hot initiatives: Where2.0 conference URL: <http://conferences.oreillynet.com/where2006>, geodata.gov URL: <http://gos2.geodata.gov/wps/portal/gos> and [openlayers.org](http://openlayers.org).

#### **S.10 Dallas Meggit**

End user needs to be able to change what they and input their own objects into the GIS tool/space. Many features sound great, but implementation sounds hard.

#### **S.11 Dr. Richard Puk**

We still have not strictly defined what an “X3D Earth” actually is. The infrastructure enhancements: need to determine who populates X3DE data. X3DE data needs to be discoverable, filterable and accessible by end users. Everything is about the data, what you do with it, where is it, tell somebody else where it is, formatting, protocols – all are in need of a maintenance distribution cycles. Mostly, we will need a server side X3D specification to allow user to gain access to subsections of required data.

Need to refine/improve definition of X3DE which provides a high-level context for requirements.

### **S.12 Alan Hudson**

Need to be able to provide users with elevation data complete with spot heights. Need base-level high-quality Earth imagery files along with the terrain/elevation data.

Important architectural feature: catalog of free data services.

Showing government agencies how to expose data, getting their support, buy-in and sponsorship

The architecture of this project needs to support commercial products so that there is a way to attract a reliability factor that we ourselves are not willing to pay for. Enabling commercial business models is important, but specific business models are not the focus of the working group.

Putting out free assets from X3D Earth and MS Earth led the way so we need to put free data out there in our earth to encourage users to join. Google is a file server of data from ESRI. The data has to be easily digestible for 3D consumption.

### **S.13 Leonard Daly**

I haven't heard any specific definition of an "end user" for this project. Sponsors should be able to supply money to enhancing this project since development time will take considerable funding.

Energy exploration and extraction can be a potential pool of users. The military and other agencies working on Anti-terrorism/Force Protection practices have been identified.

I want to emphasize the need for multi-temporal data. Being able to identify the change in the scenes is very important to a large number of users for tracking changes in the surface appearance. These users work for governments (local to world) for land use planning, emergency planning and management, ecological change tracking, national security, tactical planning, and global climate change.

#### **S.14 Douglas Maxwell**

Multi-spectral and multi-dimensionality are key features, but multi-temporal should be an aspect well. A while ago I explained why I could not use Google Earth, but from a technical standpoint, but Google Earth is not and can not be accessible over the Secret Internet Protocol Router Network (SIPRNET). Simply put, this needs to happen with X3DE.

Web Services have been proven and work on the SIPRNet and this is good news since this is the web-based architecture that we have discussed.

Analysts have brought pre-printed maps into the Sensitive Compartmented Information Facilities (SCIF) to have as a point of reference when conducting battle damage assessment since what you typically see is only a damaged building and no point of reference of where this building might be located.

How do we handle lots of entities, such as (200 ... 200K) active participants?

Special issue: anomaly detection within (or in comparison with) regular datasets

Would like to see specification since we have worked in a vacuum on our value-metric datasets, so, since we are getting ready to create our next generation of our database, this is a good time to incorporate input into a standard. A mutual benefit to cooperation and early adoption.

Would like to have some confidence in meshing algorithms used. Need to be careful that a really smooth mesh is not always possible and to not expect high-quality for each request, however, end users will likely not trust a bad looking scene.

#### **S.15 Rick Goldberg**

We have multiple different layers, multiple different times, quality of data issues, etc., how are these all sorted out?

How closely is virtual ownership close to physical ownership?

There are all kinds of standards, protocols and techniques for actually doing all of this work.



Entry-level resources from the OpenGIS community might be most helpful since a lot of our discussed issues have most likely been addressed (and possibly solved) already.

#### **S.16 Chris Thorne**

Chris Thorne sees X3D as a rich media type that we should employ as a use-case or as something solvable for our own ecosystem; using our own technology will help us drive requirements for X3D Earth.

#### **T. DR. AMELA SADIGIC – WHAT DOES SUCCESS LOOK LIKE?**

Different mechanisms for feedback mechanisms

- 2<sup>nd</sup> Life, artificial economies
- IP Multimedia Subsystem (IMS)
- Creative Commons
- Wikipedia

Went over some very well founded, tried and true open-source codebase project management best practices.

#### **U. DISCUSSION – WHAT DO YOU AS END USERS NEED?**

Toni Parisi moderating. Each participant asked to take the role of an end user in their areas of expertise.

##### **U.1 Douglas Maxwell (NUWC)**

Need to be able to access data on secure networks. Need to access underwater bathymetry and sound speed profile data.

US Navy fleet operations need a 3D reconstruction and analysis tool for viewing battle-group maneuvers. Data is recorded and moved to a server so analysts can use the SIPRNet to connect to their website to get the exercises they need. They can then replay

these in real-time so speed is important. Users select geo-specific events with position, participators, etc. Have animations of P-3 aircraft coming in. Overlay trails, anything are possible. Simulation, animation with time control in the ocean context only, anywhere in the world. The current database is populated with VRML and they just finished adopting the X3D converter. Why our X3D Earth and not a commercial system? Because they need ocean knowledge, and a large volumetric location database. The detection (sonar) radii really need volume rendering. The system needs to be totally accurate, which includes precise physics computations and environmental data.

Mike Moody notes that Volume Rendering of data is painful on delivery times and cost.

These exercises can get quite large, so laying down a flat planar surface doesn't cut it. The distributed web based service allows users to get the content they want to see. Users are analyzers who get exercises and they need to figure out what is going on in the environment. They look for statistical outliers and throw that away for instance. They use their own sensors to gauge where they are and they can find out quickly if they are wrong or not. Sensors are analyzed for their effectiveness.

Google Earth™ is useless for water. Constrained definitions for the Earth make it less than optimal.

Mike McCann says isosurface data provides a better representation than volumetric data and is cheaper for many applications. This approach is both push and pull. Annotation and corrections are also possible using this approach.

## **U.2 Chris Nicholas (Planet 9)**

Wants X3D Earth to handle a generic urban warrior, for example. Need decision support in the field; many things occur on the fly in a dense urban environment. Expect to use coordinates around the area of interest. Capture and authenticate geospatially referenced media streams, such as head-mounted video/voice from first responders. Needs accurate urban scale: character animation, ability to do ground collision detection, moving vehicles, sound, video. An extensible mechanism of nodes is highly desirable.

Need arbitrarily large scene graphs, good paging, good scene graph authoring. Wants to traverse in high resolution along the way. Page in large scene graphs: customers: first responders, “doom” navigation mode for rapid-response teams, etc. Miscellaneous mode: commercial/consumer developers needing media fusion. Needs authorization capabilities and authorization/administration delegation.

Need video provided to a squad car, and that video captured... Need actors/entities to act in a realistic urban environment, need to move from outside to inside buildings in these environments. Need moving vehicles, sound and other such plug-ins to extend my environment. Need to traverse in high-resolution from San Francisco and San Diego and be able to traverse indoors as well.

I’m very familiar with optimizing runtime engines and am willing to work off hours to do just this. Need to be able to page in arbitrary large amounts of scene-graphs. The customers I need to support are first responders, Emergency Medical Services (EMS) responders, fire, police, etc. I also need to support real estate developers.

Media fusion, audio, video, high-resolution images need to be fused, both indoor and outdoor, at street level, where actual rendering is needed. Need out-of-band communications to get telemetry data.

Focus on visualization of consistent model of outside world all the way to inside world, in a cohesive way. I can’t look horizontally at street level, nor am I able to look or go inside buildings with the other Earth models. Need to also do some animations, authenticate via Hypertext Transport Protocol (HTTP) and update entities on the fly.

### **U.3 Mike McCann (MBARI)**

The market to oceanographers is small, but the need to view underwater scenes will continue to exist. It will also be important to extend iso-surfaces to volumetric data. Wants oceanographers to be able to use X3D Earth in the same way as oil and gas.

#### **U.4 Chris Thorne (Ping Interactive)**

Use case: online underground mining-accident reconstruction. Engineers need to look at what conditions were before an accident, see what actually occurred as a result of those causes, and then determine the consequences uncloaked as the result of the accident. Need to visualize escape routes, perform distance measurements, conduct safety planning and recovery from mining accidents.

Need to go from wherever in the world, zoom down to a level and go into a mine. Need to be able to dynamically modify the scene, drill, etc.

The other Earth models don't cater to my data needs, nor would be willing to allow me to host my own data, and if they did, would charge me to use my own data!

Synchronization is not yet solved. Multi-user does not equal database synchronization directly.

#### **U.5 Alan Hudson (Yumetech)**

Need to determine the multi-user domain management issues. Tony Parisi and Don Brutzman explained that the Web3D Consortium should not be the head of data management issues, but also discussed with the fact that data synchronization is not addressed well beyond any other working groups. Perhaps it should be considered as part of our problem solving strategy.

#### **U.6 Mike Moody (Schlumberger)**

The Earth part for me that is important is connecting sub-surface area and the ability to go directly to that area, fly to different zones, perform comparison analysis on these sites.

Google Earth™ and Microsoft Virtual Earth™ are deemed to be the best applications in their respective classes, recognized by industry experts in the field.

## **U.7 Parting shots from participants that have to depart.**

Tony: Let's keep this smart. We as adults can impose a certain discipline on the process. Let's solve the important issues and strive NOT to take on more work.

Raj: Let's get the streaming terrain issues solved and be able to work on going into buildings.

Rob G.: There are still a lot of "what is a user" kinds of questions being asked. There are many kinds of users ranging from technical users to people who pay guru's to develop something for that user.

General comments:

Several: Embed X3D earth in consumer ready applications. Many consumer and industry applications can be mashed up with X3D Earth along with X3D and the web in general.

Dick Puk: Pagable, mergable scenegraphs. Grab data and merge for data source merging. Need more hyperlinking to groups, geometry and annotation for instance. Streaming is important.

Chris N: focus on what is fundamentally 3D that is not provided yet (or in 2D) so that we can focus on the value added of 3D graphics in X3D Earth.

## **U.8 GeoScience Australia**

Has anyone looked at these web resources?

DabbleDB URL: <http://dabbledb.com>

Cellestia URL: <http://www.shatters.net/celestia>

Sintef URL: <http://www.math.sintef.no/Geom/index.html>

**V. ROB GLIDDEN – DEFINITIONS OF WHAT AN X3DE USER IS AND WHAT THE USER COMMUNITY IS**

What is it that is going to be useful by someone? What are the meaningful categories in this project?

Mashers – people who search for, take collections data and try to interconnect them and may publish the results of that effort

Data providers

Vendors

Guru's – knowledge people who have connotative skill sets to offer

End users – viewers of the products, data, model of the world

Analysts – viewers who repackage fused data for presentation to decision makers

Programmers

Needs a platform to get results

Makes the tools used by authors

Authors == Creators of X3D

Content providers

Agents – servers accessing X3D Earth

Sponsors/Stakeholders

Liaisons

**W. RITA TURKOWSKI (WEB3D CONSORTIUM)**

A conformance/performance test lab has been stood up and a conformance tester has been selected.

Overview of Web3D membership levels:

	Directing	Organizational	Professional
Dues: Large	\$15,000	\$7,500	
Dues: Standard	\$5,500	\$3,500	\$100
Dues: Small Academic / Student	\$5,500	\$1,500	\$25
Membership Approval Needed	By Board	None	None
Seat on Board	Yes – if desired	By election	By election
Working Group Participation	Yes	Yes	Yes
Vote in working groups	One Vote	One Vote	No
Vote on Bylaws change	Yes	Yes	No
Waiver of Adopters Fees	Yes	Yes	No

Table 1. Web3D Membership Levels

Stressing the utmost importance of membership in order to have a voice in the direction of how X3DE will proceed.

What are the benefits of Charter Level Membership? You become part of the board and have a directing voice in how business is conducted. You will have access to what is known hot and what is not.

Q. Should the GeoSpatial Working Group be subsumed by the X3DE Working Group?

A. We will need to draft a charter detailing what are goals are and what the deliverables will be. A comparison of charters would be prudent at this time. If there are parallel goals to achieve, greater forward motion may be achieved by combining into one Earth/GeoSpatial Working Group. Will need to keep X3D Working Group focused and the specification and technical issues however.

What are the metrics/measures of an X3DE Working Group success and what deliverables will be required? From this knowledge, we will have a clearer picture of who would desire stakeholder-ship in areas of development. The number of mashups and the number of X3DE applications may be a good metric. Reference server architecture, as well as additions to the X3D specification will need to be considered for a charter.

Refine from workshop requirements; produce goals that are strategic.

Compliance verification is a good litmus test for, and must be a requirement for, procurement.

Will need a meeting in January or February:

- W/G kickoff, “finish” charter
- Demonstrate capabilities
- Open and recorded, but subsequent meetings are for members only)
- getting the word out.
- potential members and press
- DEMOs!

Outreach in other meetings:

- I/ITSEC
- OGC technical meeting
- W3C technical plenary in conjunction with GEOIncubator
- Press releases

Don Brutzman, Mike McCann and Len Daly will spearhead the first draft charter for the new X3DE Working Group.

## **X. WEB 3D 2007 SYMPOSIUM**

- Send in papers!
- Friday, April 19<sup>th</sup>, 2007 in Perugia, Italy
- 2-tracks
  - Requirements and use cases
  - Technology and specification work



**Y. CLOSING COMMENTS – DON BRUTZMAN**

The thing about working with a large group is the fact that things seem to move slow at first because we have to feel each other's needs and contributinal potential, but we will prevent ourselves from marching into a hole because someone is always mindful and keeping watch against this. Thus the process and "wisdom of the group is more valuable to everyone, and more valuable to ourselves.

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## **V. CONCLUSIONS AND RECOMMENDATIONS**

### **A. CONCLUSIONS**

The following conclusions and recommendations for future work were composed by the moderators. Group discussion resulted in several improvements and additions. Attendees agreed that the points provided a good summary of the workshop presentations and dialog.

#### **What We're Seeing**

- Lots of compelling success stories
- Apparently composable technical approaches
- Complementary standards and organizations
- Diverse disconnected projects
- Confluence, overlap, agreement
- Substantial discussion on many overlapping points of interest

#### **What We're Not Seeing**

- Coherent use cases for design requirements
- Major controversies or major conflicts
- Any other common-denominator 3D format
  - although not everybody is here today
  - and what about maps?
- Confusion about what is needed next
- Detailed server architecture, context etc.
- How is it different from all the other “earths”

## **Observations**

- Commercial products appear to have best quality, but free versions can be competitive
  - NASA WorldWind demo was compelling
- Numerous data products available openly, from governments etc.
  - similar or better coverage to commercial products
- Commercial products appear to be serving different end users

## **Workshop Conclusions**

- X3D Earth is feasible
  - This effort can be started now
- Many resources are already available
  - Work needed to make them compatibly available
- No showstoppers found
  - A nice surprise after so many diverse inputs
- Lots of collaboration and coordinated work are needed to proceed successfully
  - Are we building a web-services infrastructure?
  - Server-side specification might be most important activity

## **B. RECOMMENDATIONS FOR FUTURE WORK**

Start an X3D Earth working group to tackle these many issues, in concert with Open Geospatial Consortium (OGC), World Wide Web Consortium (W3C) and other relevant standards organizations.

Let the construction of X3D Earth capabilities guide the development of assets, documentation of best practices, and specification of relevant standards.

## APPENDIX A. X3D EARTH TECHNICAL REQUIREMENTS WORKSHOP CALL FOR PARTICIPATION



### Call For Participation X3D Earth Requirements Workshop



#### Requirements, Capabilities, Challenges, Partnerships and Next Steps

Naval Postgraduate School, Monterey California USA  
14-15 November 2006

**Summary of X3D Earth goals.** Web3D Consortium members are preparing to build a standards-based X3D Earth usable by governments, industry, scientists, academia and the general public. X3D mappings of world terrain, cartography and imagery will be made available for use in any scene, making it easy to geospatially reference and share X3D models. Open standards, the Web architecture, XML languages and open protocols will be used throughout. Both commercial and open-source software codebases will be able to utilize these best practices and contribute to these shared assets.

**Workshop goal.** Participants will identify and prioritize the technical requirements, available capabilities, open challenges and strategic partnerships needed for a Web3D working group to execute this ambitious project. Emphasis will be placed on extensibly adapting existing resources and cooperating to achieve shared goals, especially with other open geospatial organizations and standards. Workshop results will document participant contributions, next-step activities and goal milestones.

**Submission requirements for attendance.** Prospective participants are requested to submit a brief abstract discussing why they should attend. Prior to the workshop, all attendees must provide a 2-4 page summary and short slideset regarding their area of interest, so that all participants can contribute to achieving our “big picture” goals.

Whitepaper topics include following issues:

- Strategic goals statement for community or domain of interest
- Requirements for X3D Earth technical architecture and shared implementations
- Assets already available: datasets and datastreams, software, hardware, labor, etc.
- Access and intellectual property rights (IPR) restrictions
- Unresolved challenges and open questions that still need to be addressed

Participation in this workshop is open to all interested stakeholders whose input abstracts are accepted. Each workshop participant will be able to present a summary of their goal requirements, available assets and continuing efforts. Ongoing participation in subsequent X3D Earth Working Group activities will only be available to institutional and professional members of the Web3D Consortium.

**Workshop agenda.** This is a fast-paced, action-oriented workshop requiring participant preparation.

- Day 1: Conference attendee briefings
  - X3D Earth overview, mission statement, and Web3D working group process (1 hour)
  - Participants each present their stakeholder issues. (10 minutes each, plus questions)
- Day 2: Building consensus (diff/merge bashing and matchup!)
  - Breakout groups compare/contrast/merge sets of goals, assets and challenges
  - Full group review of all proposed recommendations and goal outcomes
  - Proposed initial calendar, plan of actions and milestones

**Dates of interest.**

- October 20: initial deadline, 1-page abstract submission
- Ongoing submissions allowed until workshop, with immediate notification of acceptance
- November 7: requested submission of whitepaper and slideset for advance participant review
- November 14-15: X3D Earth Requirement Workshop in Monterey

**Organizers.**

Dr. Don Brutzman (brutzman at nps.edu) 1.831.656.2149  
Dr. Amela Sadagic (asadagic at nps.edu) 1.831.656.3819  
Modeling Virtual Environments and Simulation (MOVES) Institute,  
Naval Postgraduate School, Monterey California USA.

**Administrative items.**

- Website: <http://www.web3D.org/x3d-earth>
- Email for submission and registration questions:  
[x3d-earth-workshop@MovesInstitute.org](mailto:x3d-earth-workshop@MovesInstitute.org)
- Publication: Final presentations and papers will be published online as a workshop report.
- Participation: The workshop invitation list is limited to approximately 30 people based on meeting-space requirements.
- Hotels: <http://www.nps.navy.mil/moves/hotels.htm>
- Directions: <http://www.nps.edu/Aboutnps/Navigation/Directions.html>
- Cost: A requested contribution of \$10 will pay for light refreshments. Lunch can be conveniently purchased on campus. A group dinner is planned for the evening of Tuesday November 14.

**Dissemination of information.**

- All technically sound written submissions will be accepted and published online as part of the X3D Earth public website. Ability to attend the workshop is not a prerequisite for inclusion.
- Contributions may be published immediately if desired. The organizers recommend this approach in order to gain the benefit of immediate dialog on the public mailing list.
- Contributors may modify or defer publication of their contributions prior to the workshop. Afterwards, all contributions are online and publicly available.

Adoption of candidate technologies for potential inclusion in the X3D standard requires that each submitter provide technology contributions available for royalty-free (RF) use on the Web. Further details are provided in the Web3D Consortium Intellectual Property Rights (IPR) Policy, available as Appendix A in the Web3D Member Agreement.

<http://www.web3d.org/membership/join>

Further information on Web3D and the ISO-approved Extensible 3D (X3D) Graphics standard can be found online at <http://www.web3D.org>

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## APPENDIX B. LIST OF WORKSHOP ATTENDEES

X3D Earth Technical Requirements Workshop			
First name	Last name	email	Affiliation
<b>Presenting and attending</b>			
Craig	Anslow	<a href="mailto:Craig.Anslow@mcs.vuw.ac.nz">Craig.Anslow at mcs.vuw.ac.nz</a>	Victoria Univ. of Wellington, NZ
Don	Brutzman	<a href="mailto:brutzman@nps.navy.mil">brutzman at nps.navy.mil</a>	NPS
Leonard	Daly	<a href="mailto:Leonard.Daly@realism.com">Leonard.Daly at realism.com</a>	Daly Realism
Rob	Glidden	<a href="mailto:rob.glidden@sbcglobal.net">rob.glidden at sbcglobal.net</a>	
Rick	Goldberg	<a href="mailto:rick@aniviza.com">rick at aniviza.com</a>	Aniviza Inc.
Julian	Gomez	<a href="mailto:jeg@polished-pixels.com">jeg at polished-pixels.com</a>	Polished Pixels
Shun-Yun	Hu	<a href="mailto:syhu@yahoo.com">syhu at yahoo.com</a>	National Central University Taiwan
Alan	Hudson	<a href="mailto:giles@oz.net">giles at oz.net</a>	Yumetech
Doug	Maxwell	<a href="mailto:MaxwellDB@Npt.NUWC.Navy.Mil">MaxwellDB at Npt.NUWC.Navy.Mil</a>	NUWC, Newport RI
Mike	McCann	<a href="mailto:mccann@mbari.org">mccann at mbari.org</a>	MBARI
Perry	McDowell	<a href="mailto:mcdowell@nps.edu">mcdowell at nps.edu</a>	NPS
Dallas	Meggitt	<a href="mailto:dmeggitt@soundandsea.com">dmeggitt at soundandsea.com</a>	Sound + Sea Technologies
Michael	Moody	<a href="mailto:mmoody@slb.com">mmoody at slb.com</a>	Schlumberger
Chris	Nicholas	<a href="mailto:cnicholas@planet9.com">cnicholas at planet9.com</a>	Planet 9 Design Studios
Terry	Norbraten	<a href="mailto:tdnorbra@nps.edu">tdnorbra at nps.edu</a>	NPS
Tony	Parisi	<a href="mailto:tparisi@mediamachines.com">tparisi at mediamachines.com</a>	Media Machines
Dick	Puk	<a href="mailto:puk@igraphics.com">puk at igratics.com</a>	Intelligraphics
Michael	Ramsey	<a href="mailto:Michael.Ramsay@mortenson.com">Michael.Ramsay at mortenson.com</a>	Mortenson
Amela	Sadagic	<a href="mailto:asadagic@nps.edu">asadagic at nps.edu</a>	NPS
Raj	Singh	<a href="mailto:rsingh@opengeospatial.org">rsingh at opengeospatial.org</a>	Open GIS Consortium (OGC)
Jon	Stirzaker	<a href="mailto:Jon.Stirzaker@ga.gov.au">Jon.Stirzaker at ga.gov.au</a>	Geoscience Australia
Chris	Thorne	<a href="mailto:dragonmagi@gmail.com">dragonmagi at gmail.com</a>	Ping Interactive
Rita	Turkowski	<a href="mailto:rita.turkowski@web3d.org">rita.turkowski at web3d.org</a>	Web3D Consortium
Keith	Victor	<a href="mailto:kvictor@cinci.rr.com">kvictor at cinci.rr.com</a>	Media Machines
<b>Contributing</b>			
David	Colleen	<a href="mailto:dcolleen@planet9.com">dcolleen at planet9.com</a>	Planet 9 Design Studios
Mike	Heib	<a href="mailto:mhieib@gmu.edu">mhieb at gmu.edu</a>	George Mason University (GMU)
Patrick	Hogan	<a href="mailto:Patrick.Hogan@nasa.gov">Patrick.Hogan at nasa.gov</a>	NASA
Paul	Keller	<a href="mailto:Paul.J.Keller@nasa.gov">Paul.J.Keller at nasa.gov</a>	NASA NExIOM
Nick	Polys	<a href="mailto:npolys@vt.edu">npolys at vt.edu</a>	Virginia Tech (VT)
Mark	Pullen	<a href="mailto:mpullen@gmu.edu">mpullen at gmu.edu</a>	George Mason University (GMU)

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## **APPENDIX C. X3D EARTH TECHNICAL REQUIREMENTS WORKSHOP AGENDA**

### **X3D-Earth Requirements Workshop MOVES Institute, Naval Postgraduate School November 14-15, 2006 Watkins Annex Rooms 375/384**

#### **Workshop Goal**

Participants will identify and prioritize the technical requirements, available capabilities, open challenges and strategic partnerships needed for a Web3D working group to execute this ambitious project. Emphasis will be placed on extensively adapting existing resources and cooperating to achieve shared goals, especially with other open geospatial organizations and standards. Workshop results will document participant contributions, next-step activities and goal milestones.

The workshop will begin with presentations from whitepaper contributors. Whitepaper topics include following issues:

- Strategic goals statement for community or domain of interest
- Requirements for X3D Earth technical architecture and shared implementations
- Assets already available: datasets and datastreams, software, hardware, labor, etc.
- Access and intellectual property rights (IPR) restrictions
- Unresolved challenges and open questions that still need to be addressed

#### **Agenda**

##### **Day 1: Tuesday, November 14**

0800-0830	Registration (and choose lunch selection)
0830-0845	Welcome & Introductions (Don Brutzman, NPS MOVES)
0845-0900	X3D-Earth Project Overview (Don Brutzman)
0900-1030	Contributor Presentations
1030-1045	Break
1045-1200	Contributor Presentations
1200-1300	Working Lunch
1230-1300	X3D Geospatial Capabilities
1300-1430	Contributor Presentations
1430-1445	Break
1445-1600	Contributor Presentations
1600-1700	Group Discussion & Plan of Action for Day 2 Breakout Groups

- 1700-1800      NPS Demonstrations & Reception  
                     Anti-Terrorism/Force Protection Analysis Tool – Watkins 267  
                     Autonomous Unmanned Vehicle Workbench – Watkins 375  
                     Delta3D Open Source Game Engine – Watkins 212
- 1900              Dinner: Tarpy's Roadhouse, Route 68 (10 minute drive)

## **Day 2: Wednesday, November 15**

- 0800-0830      Day 2 sign-in, break-out group assignments & choose lunch selection
- 0830-1130      Breakout Groups  
                     Group I: Wa-375 (moderator: to be selected by the group)  
                     Group II: Wa-384 (moderator: to be selected by the group)
- 1130-1200      Working Lunch
- 1200-1300      Breakout Group Presentations
- 1300-1400      Group Discussion: Align Issues & Identify Controversies
- 1400-1500      Lessons Learned, Conclusions and Recommendations  
                     (Amela Sadagic & Don Brutzman)
- 1500-1530      Web3D Consortium Working Group Process  
                     (Alan Hudson & Don Brutzman)
- 1530-1600      Next Steps: Structuring for Success & Avoiding Pitfalls  
                     (Don Brutzman)
- 1600              Workshop Concludes

## **Follow-on efforts**

- final copies of presentations and point papers for public release
- digitized video of presentations (but not discussions)
- workshop assessment report
- commence X3D Earth Working Group, <http://www.web3d.org/x3d-earth>

# APPENDIX D. WEB3D CONSORTIUM 2007 SYMPOSIUM CALL FOR PROPOSALS

*Call for Papers*

## Web3D 2007

12th International Symposium on 3D Web Technology



15-18 April 2007  
University of Perugia, Umbria, Italy  
Sponsored by ACM SIGGRAPH  
<http://www.web3d.org/web3d2007>



web|3D  
CONSORTIUM

Twelfth in the series, the Web3D 2007 International Symposium will address a wide range of topics about 3D and Multimedia on the Web. Topics include languages, tools, rendering techniques, human-computer interaction, mobile devices and innovative applications. As in previous years, this event will be sponsored by ACM SIGGRAPH and held in cooperation with both EuroGraphics and the Web3D Consortium.

The annual Web3D Symposium is a major event which unites researchers, developers, experimenters, and content creators in a dynamic learning environment. Attendees share and explore methods of using, enhancing, or creating new 3D Web and Multimedia technologies, such as (but not limited to) X3D, VRML, MPEG4, MPEG7, U3D, Collada, Acrobat3D and Java3D. The symposium will also focus on recent trends such as interactive 3D graphics and applications on mobile devices.

Authors are invited to submit their work (short or full papers) for review by the international Program Committee. Both research and applications papers are of interest to Web3D 2007. The papers must be innovative and contribute to the advancement of 3D technologies on the Web and on Multimedia. Topics of interest include but are not limited to:

- Interactive 3D graphics for PDAs and cellular phones
- Innovative 3D graphics applications for Web/Multimedia in industry, science, medicine, and education
- User-interface paradigms and interaction methods for real-time 3D graphics virtual environments
- Animated humanoids and complex reactive characters
- High-performance 3D graphics for distributed environments and tele-operation systems
- Integration and interoperation with other Web/Multimedia standards, including SVG, SMIL and Semantic Web technologies
- Methods for modeling and rendering complex geometry, structure and behaviors

Authors are invited to submit full papers of up to 9 pages (including figures and references) or short papers of up to 4 pages (including figures and references) in PDF format via the Symposium Submission Site. Papers must be formatted using the document templates for conferences sponsored by ACM SIGGRAPH. After acceptance, the final revised paper is required also in electronic form. Accepted papers will appear in the Symposium Proceedings, published by ACM Press.

<b><u>Information and questions</u></b>	<a href="mailto:web3d2007@web3d.org">web3d2007@web3d.org</a>	<b><u>General Chair, Co-Chair</u></b>	<b><u>Program Chairs</u></b>
<b><u>Schedule</u></b>		Osvaldo Gervasi	Roberto Ranon
Full Paper submission deadline:	December 14, 2006	University of Perugia, Italy	University of Udine, Italy
Short Paper submission deadline:	December 14, 2006	Don Brutzman	Nicholas Polys
Tutorial proposals deadline:	December 14, 2006	Naval Postgraduate School, USA	Virginia Tech, USA

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## LIST OF REFERENCES

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